THE FOUNDRY

Vol. 42, No. 12 Cleveland, Ohio, December 1914 Whole No. 268

Test on Melting Shot Iron in the Cupola

Interesting Details of a Successful Experiment in a Stove Foundry—Over 7,000 Pounds of Shot Were Charged and 76.7 Per Cent Recovered in Good Castings

By G E Pickup

FROM time to time there has been considerable discussion on the subject of using shot iron or reclaimed iron from the water-milled cupola drop in regular heats or mixtures in the cupola. Claims have been made by experts and well informed foundrymen that using this shot iron would seriously interfere with the grade of castings as it was hard to melt and would appear in spots and shot form in the castings and, therefore, they do not advise using it in regular mixtures for stove plate castings. Furthermore, it is claimed that the percentage of saving would not compensate the cost of the mill, labor for operating it, to say nothing about the bad effect it would have on the regular mixture.

In a recent experiment at the plant of the Wehrle Co., Newark, O., the largest stove foundry in the world, of which the writer is general superintendent, a thorough and systematic test was made on the use of shot iron reclaimed from the cupola drop by the water mill process. The results of the tests show that 76.7 per cent of good iron was reclaimed.

It can readily be appreciated that placing 7,220 pounds of shot iron in a cupola would produce a very compact mass, preventing escape of the gases. To overcome this and prevent the shot iron from mixing with the bed coke, 300 pounds of stove plate were placed on the bed, this facilitating the melting of the shot iron. The balance of the small shot charges were put in the cupola the regular way.

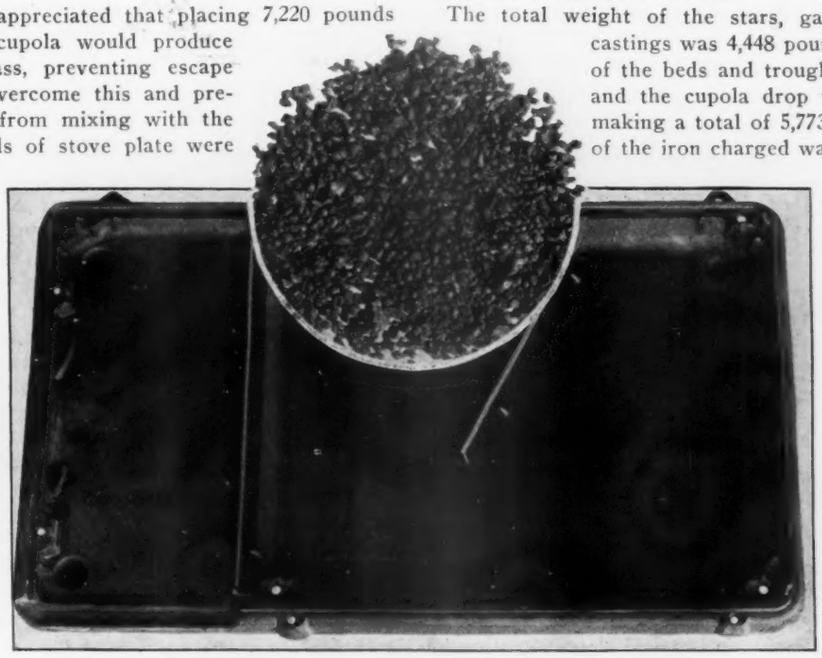
While it may not be practical to run special heats to melt recovered iron, it serves the purpose of showing what can be reclaimed from the cupola drop and the advantages of remelting shot iron in cupolas. By the use of the shot, the silicon was reduced while the sulphur was increased. An itemized statement of the stock used follows:

	Pounds.
Shot iron charged	7,220
Stove plate scrap	300
Total	7,520
Coke charged	2,400
Coke recovered	350
Limestone charged	360

Following is a list of castings poured from this heat, among which was one cast cook main bottom, 19 inches wide and 31 inches long, shown in the accompanying illustration:

No.	Casting.
1	Cook main bottom.
2	Cook reservoir tops.
40	Laundry stove, iron holders.
64	Laundry deflecting plates.
8	Stove feet.

The total weight of the stars, gates and stove plate castings was 4,448 pounds; the total weight of the beds and troughs was 1,175 pounds; and the cupola drop weighed 150 pounds, making a total of 5,773 pounds. The weight of the iron charged was 7,520 pounds; good iron, 5,773 pounds, and the shrinkage, 1,747 pounds, the percentage of iron reclaimed being 76.7.



SHOT IRON RECOVERED FROM THE CUPOLA DUMP AND A STOVE PLATE CASTING MADE FROM A SHOT IRON MIXTURE; THIS BOTTOM PLATE IS 19 x 31 INCHES

The castings which were poured with the shot mixture were then analyzed and a comparison of this analysis with that of the regular mixture, follows:

Regular mixture: —Silicon, 2.68 per cent; sulphur, 0.085 per cent; manganese, 0.51 per cent; phosphorus, 0.595 per cent, and to-

tal carbon, 4.2 per cent. *Shot iron mixture:*—Silicon, 2.02 per cent; sulphur, 0.162 per cent; manganese, 0.41 per cent; phosphorus, 0.68 per cent, and total carbon, 3.23 per cent.

When experimenting with shot iron, however, it is essential to prevent the charges from being packed too closely, as this will prevent the gases from escaping and will interfere with melting the shot iron satisfactorily. The writer also finds that after the cupola drop has been water-milled and put through a No. 10 riddle, the small particles of iron which are hard and of irregular shape, can be used in a sand blast for cleaning castings to good advantage and with excellent results.

Titanium Steel Converter Tops

The Prime Steel Co., Milwaukee, recently has completed an order for a number of Bessemer steel converter tops of unusually thin section considering the size and weight of the castings. Each casting is solid steel, weighing 15,000 pounds, 13 feet in diameter at the bottom and 6 feet high, with a flange 1½ inches thick around the lower edge and walls 1⅛ inches thick. The shape of the tops is that of a truncated eccentric cone as shown in Fig. 2.

The pattern was of skeleton form as shown in Fig. 1. The top was cast right side up in a 14-foot concrete lined pit, also shown in this illustration. A flat surface was struck off at a level that kept the upper cheek joint 6 inches below the top of the pit on account of the great strain on the mold while it was being poured. The skeleton pattern was 1-inch in thickness, ⅛-inch less than the thickness of the completed casting.

The cheek and cope were rammed up in the usual way, the sand between the strips of the skeleton pattern being cut off before the pattern then was drawn off the core. Although the thickness called for was 1⅛-inches it was decided to use a pattern thickness of 1-inch throughout to allow for the deformation resulting from cooling strains. The calculations proved correct as the measurements were true throughout the shell.

One central gate and eight runners were used, making a complete distribution of the steel throughout the surface of the shell. Titanium alloys were used in the steel, eight pounds to the ton being introduced in the ladle.

FIG. 1—SKELETON PATTERN FOR CONVERTER TOP WITH CORE IN BACKGROUND

FIG. 2—CAST STEEL CONVERTER TOPS AS THEY CAME FROM THE SAND

A Water-Proofing Material

The use of iron cement, produced by the Smooth-On Mfg. Co., Jersey City, N. J., for repairing defects in castings, is well known to the trade. This compound, however, has many other applications and it is now put up in forms which make it applicable for water-proofing, dust-proofing and oil-proofing concrete floors or for water-proofing stone walls, wooden tanks, roofs, pavements, etc. For these purposes, if desired, it may be mixed with Portland cement and sand, making what is said to be a thoroughly waterproof concrete. It is stated that the material is absorbed into the concrete, combining with it mechanically and chemically, making it heavier, denser, harder and waterproof. When applied as a wearing surface on concrete floors, it metallizes sufficiently hard for light traffic in four days and for heavy traffic in 10 days. A booklet recently has been issued by the Smooth-On Mfg. Co. giving detailed directions for using Smooth-On for the various purposes suggested above.

St. Louis Foundrymen's Club

At the regular meeting of the St. Louis Foundrymen's Club at the Marquette Hotel, St. Louis, Nov. 14, two interesting papers were presented. H. S. Gulick, metallurgist of the More-Jones Brass & Metal Co., presented a paper on copper alloys, and W. G. Roepke, chief chemist, Commonwealth Steel Co., read a paper entitled "Characteristics of the Elements in Iron and Steel." The meeting was well attended and the discussions were extremely interesting.

The Pine Bluff Welding Co., Pine Bluff, Ark., has been organized by F. B. Cowan, O. D. Glenn and W. L. McClellan. A plant has been established at Pine Bluff, equipped with oxy-acetylene equipment which has been installed.

The Wood Shovel & Tool Co., Piqua, O., has purchased the following equipment from the American Blower Co., of Detroit: Two air washers, two cyclone separators, two heating coils and two large fans.

Foundry Cupola of New and Interesting Design

Description of a Heavy Duty Melting Furnace for Heats of Long Duration—Individual Blast Boxes Take Place of Windbox

By G R Brandon

THIS article will describe a new cupola designed with the special object of meeting the severest service requirements for large capacity and heats of long duration such as obtain in pipe and wheel foundry practice, and also in implement and machinery foundries of the largest output.

The development of this design has been gradual, the first cupola of this type of construction having been installed in 1908. To increase ease of handling and simplify the construction certain details have been incorporated. This design aims to avoid one of the greatest limitations for hard service in ordinary construction, which is the location of the tuyeres all within the windbox. An individual blast box is used for each tuyere, similar to that used in Bessemer cupolas. This simplifies cupola operation greatly. The ordinary construction of wind box which extends to bottom plate also is done away with and a wind belt substituted.

Simple attachment of tap and slag spouts to the shell is also desirable in heavy duty cupolas and a design for the base which would be of ample strength and at the same time of simple and reliable construction was considered advisable.

The construction may be described as follows: The base consists of a heavy steel plate, square on the outside dimensions and with a circular opening in the middle slightly larger than the inside diameter of the lining. This plate is securely riveted to and supported by two steel H-beams at the front and rear. These beams are supported at the ends with cast iron cylindrical columns furnished with an ample base flange to rest on concrete foundation. The top flanges of the columns are machined so as to accurately fit the flanges of the steel beam, and are bolted thereto by bolts of large diameter.

An angle bar is riveted to unsupported edges of the bottom plate to give additional stiffness. A heavy angle makes the connection between the bottom plate and shell, and is securely riveted to both. This construction gives great strength as the circular shell is of such a form as to give maximum strength against buckling from vertical loads or internal pressure and is comparable to a girder of the height of the stack to withstand vertical loads.

The windbox is of belt form with all joints calked air-tight. The blast entrance is the tangential type which introduces the air into the windbox with minimum friction.

The blast boxes are cast iron with flanges for attachment to the shell and the underside of the windbox. These joints are fitted with gaskets and are air-tight. Each blast box is provided with a peephole and cover opposite the tuyere. Also, a frame with a fusible or combustible insert is attached to the underside of each tuyere to serve as a safety device in case slag or metal over-flows the tuyere. Each blast box is also furnished with a damper for regulating the amount of air passing from the windbox to the tuyere. The tuyeres are in one row and form a continuous inlet from the shell to the inside of the lining. The tuyere castings are made in segments with a removable top all bolted together through flanges and are of rigid construction.

The top has a flange at the inner edge, extending upward and inwardly and the lining is projected to come flush with inside of flange. The diameter of the lining at this point being 2 to 3 inches smaller than at the melting zone, to which point the lining is gradually sloped.

The stack for this cupola is of heavy construction, and all the joints are riveted. Supports are furnished at

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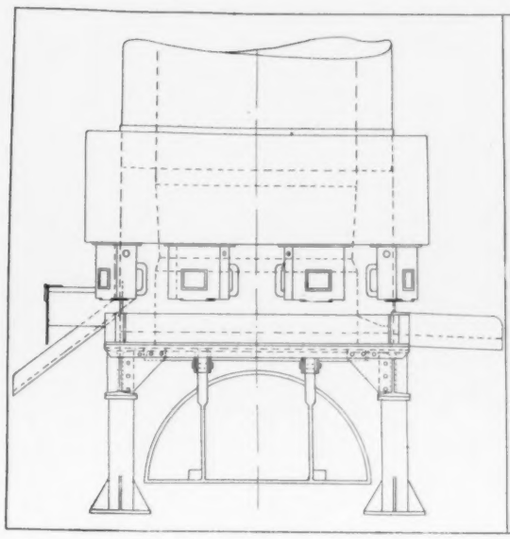


FIG. 1—ELEVATION OF HEAVY DUTY CUPOLA

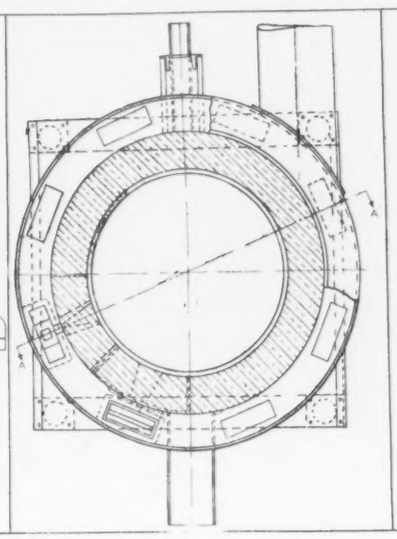


FIG. 2—HORIZONTAL SECTION

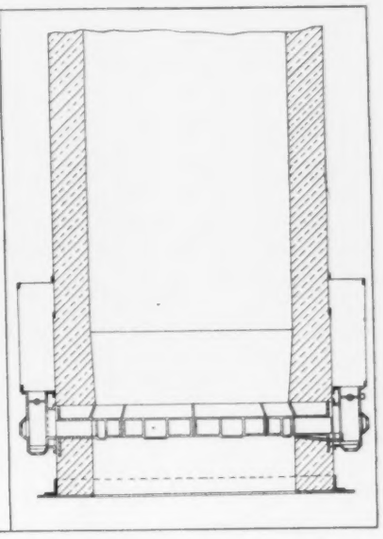


FIG. 3—SECTIONAL ELEVATION THROUGH OPPOSITE BLAST BOXES

A paper read at Chicago convention of American Foundrymen's Association. The author, G. R. Brandon, is vice president and general engineer, Whiting Foundry Equipment Co., Harvey, Ill.

Notes on Galvanizing Malleable Castings

Suggestions Covering Methods to be Followed in Cleaning, Pickling and Coating

By Enrique Touceda

WHEN two metals are placed in close contact with each other, a slight galvanic action is set up, and if they are exposed to moisture rusting is facilitated. Zinc, however, being electro-positive, will oxidize at the expense of the iron, and consequently afford protection until it has disappeared. Zinc itself when exposed to the atmosphere corrodes with extreme slowness, and this property is of great value since even with the galvanic action referred to when in contact with iron, it lasts for a long period of time. Other metals like tin or lead, due to their not being electro-positive to iron, do not act like zinc. They act simply as a covering in a similar manner to varnish or paint, though they are more resistant to destruction through outside exposure. Even if a pin hole is exposed, the iron or steel starts to rust, but in the case of the zinc-coated material this would not be the case.

In hot galvanizing the formation of zinc dross is the greatest obstacle. It is produced both by the oxidation of the zinc in the molten bath and the action of the zinc on the iron of the kettle. Zinc will absorb from 1 to 4 per cent of iron, and it happens that as each per cent is absorbed the melting point of the bath is raised, the zinc thus becoming thick and pasty, making it necessary to skim at frequent intervals. Therefore, it should be specified that spelter for use in galvanizing should contain less than 0.50 per cent iron, a provision that can be easily met by the vendor.

The best material out of which to make the galvanizing kettles is fire box steel, and even for small work the vessel should not be less than 3 feet long, 18 inches wide and 20 inches deep, for with a smaller body of metal it is difficult to control the temperature. It should be located in a room where there is good roof ventilation. A hood should be built over the kettle that will come down as low as practical, and of sufficient size to extend about 2 feet beyond the brick work around the kettle. As considerable water is used in the process, provision should be made for proper drainage, and it is well to have a cement floor with gutters at each side.

In firing up, the spelter should be placed in the kettle in such a way that it will lie as closely as possible to the sides of the kettle, and be so arranged that as the outside slabs of spelter melt, those next to them will be forced against the sides of the kettle. If this is not done the life of the kettle will be shortened. The fire should be prevented at any time from rising any higher than the surface of the bath that is being formed as the metal melts.

Before dipping the work, cover the surface of the molten zinc with a flux of sal-ammoniac, and if trouble is experienced due to an inconvenient separation of the dross, add a few drops of glycerine, which will cause the flux to thicken up and prevent it in a measure from covering the whole surface. It also causes the flux to remain stationary so that when the operator is ready to draw the article from the bath, the flux will not cover the spot he has skimmed for this purpose. The sal-ammoniac not only serves to prevent the zinc from oxidizing, but assists the iron to take the zinc quickly and evenly. A small amount of the sal-ammoniac sprinkled on the surface of the bath frequently, is much better practice than a greater amount at longer intervals.

The temperature of the bath may vary from 800 to 1,000 degrees Fahr., depending upon the character of the work to be galvanized, for which reason a pyrometer should be installed in the bath at the end of the tank so that control can be assured.

For large gray iron or malleable castings, the temperature should be as low as possible, that is, well within 800 degrees; this temperature is likewise suitable for very thin work where it is desired that the surface be highly spangled with large crystals. The thin work referred to are articles such as thin plates of metal of any size. Very small work requires that the temperature of the bath be around 890 degrees Fahr., this includes such work as is handled in baskets or that must be strung on wires.

In connection with galvanizing malleable iron castings, the most serious trouble arises from a deterioration of the metal in the casting, resulting in the casting being brittle. Another trouble arises from failure to have the surface of the castings properly prepared to take the zinc coating, which arises not, as often thought, from failure to remove all sand, but from ignorance as to the cleaning of the surface after the application of sulphuric acid. Still another trouble results from too rough and lustreless a surface of the zinc coating.

After the castings have been soft milled, and there still remains some sand, rust or scale on their surface, they should be pickled in a bath of dilute sulphuric acid, one of acid to six of water, care being taken in preparing the solution to always pour the acid into the water, and never the water into the acid. It sometimes happens that the sulphuric acid solution leaves a slime on the surface of the metal that is more or less difficult to remove. Failure to perfectly remove this will result in bad work, as there will not be a close adherence of the coating to the surface. This trouble rarely if ever occurs if, instead of sulphuric acid, hydrofluoric acid is used, in the proportions of one of acid to 20 of water. The latter acid is highly poisonous, and should not be handled by men who have not been prevously instructed in its use and in the danger of getting it on their hands when it is in concentrated form.

Sulphuric acid attacks the metal and removes the sand by virtue of its eating away the metal under the sand grains, but it is attacking the rest of the metallic surface while this is being accomplished. Hydrofluoric acid on the other hand actually dissolves the grains of sand without attacking the metal except to a very slight extent.

The usual method of handling this part of the process is not to place the castings in the bath itself, but to place them on a platform attached to the tank holding the solution, where they are wet with the solution at intervals of about an hour, the excess solution draining back into the

(*Continued on page* 478.)

How Radiator Cores Are Made Efficiently

Molding Machines, Double Ended Drying Ovens and Special Mono-Rail Equipment Are Utilized to Cut Costs

By E C Kreutzberg

IN THE manufacture of a product in which competition is unusually keen, the efforts expended in cutting costs and in increasing the efficiency of men and machines often lead to noteworthy results. Such results are to be found in the manufacture of cast iron radiators, of which many hundreds of tons are cast daily in this country. The casting and manufacture of radiators, indeed, is an industry which calls for ability of the highest order, and the more important plants devoted to this business reflect a notable degree of specialization. In no department of a modern radiator plant is this idea of specialization more manifest than in the core shop. Each radiator loop naturally requires a sepate core, and in few other foundry lines is the consumption of core sand, in proportion to the iron tonnage, so great. The performance in the core department, therefore, exerts a significant bearing upon the ultimate cost of production.

FIG. 1—CORE OVEN FOR BAKING RADIATOR CORES, SHOWING CONSTRUCTION OF CARRIAGES

A typical, modern, radiator core shop is found at the radiator plant of the H. B. Smith Co., Westfield, Mass. Here, in a building 70 x 150 feet, are produced more than 5,000 cores daily, necessitating a consumption of from 35 to 40 tons of core sand. This shop is of the continuous type, being laid out so that all stages of the process, from the preparation of the sand mixture to the distribution of the baked cores in the foundry, succeed each other with the least possible amount of handling. One of the interesting features of the shop is that the large output of cores is achieved with the aid of only six ovens. Indeed, it is largely owing to the design and location of these ovens that the splendid showing at this core shop is attainable.

These ovens are of the double-end type, being provided with doors at the front and back; thus it is possible to charge as well as remove the cores from both sides. Each oven is 16 feet long, 10 feet wide and 8 feet high; they are located along the center line of the building, where they are placed side by side. Each oven is provided with narrow gage tracks on which two core carriages can be run in abreast of each other. These carriages are 14 feet long, 7 feet high and 3 feet wide, and they are distributed four to an oven, or two on each track, as shown in Fig. 1. Thus, while two of the carriages are in the oven undergoing a bake, the remaining two trucks may be loaded with green cores. On the completion of the bake, the carriages loaded with green cores are pushed into the oven, thus discharging at the opposite ends the carriages which have been through the bake. The capacity of each carriage is approximately 300 cores, thus giving each oven a capacity of 600 cores in one bake. The duration of a bake usually is six hours, and two bakes are secured from each oven daily. In rush times three bakes may be taken from each oven daily.

FIG. 2—VIEW OF STOKING PIT, SHOWING METHOD OF APPLYING FORCED DRAFT TO FIRES

FIG. 3—COREMAKER'S BENCH, SHOWING HOW SAND IS OBTAINED FROM HOPPER

There is nothing unusual in the construction of these ovens, but their operation is conducted in a highly efficient manner, which eliminates all guess-work in determining the degree of heat and the condition of the cores at different times during a bake. Each oven is provided with a thermostat which is set to regulate the drafts, thus maintaining the heat with approximate accuracy at a given temperature. In addition, each oven is provided with a recording thermometer, which records the performance inside the oven walls. These records enable the foreman of the new gang, when the day and night shifts succeed each other, to tell with accuracy just how far each bake has progressed.

The ovens are fired with anthracite coal, from an underground stoking pit which communicates with an underground coal storage. At one end of the stoking pit is a motor driven fan which supplies air for operating the oven furnaces under forced draft. The air from the fans is rendered accessible to the oven furnaces by means of a 10-inch galvanized main, from which connections can be made to the ash-pit of each furnace. When the full pressure of the forced draft is required, this connection is introduced directly into the ash pit, while, when the full pressure is not desired, a shorter connection may be used which discharges about three feet distant from the ash-pit door; both methods of applying the forced draft are illustrated in Fig. 2. The practice followed in baking cores, is to employ the forced draft at the beginning of the bake, thus running the temperature in the oven up to 380 degrees, Fahr., in the first hour. During this period the cores still are green and hence sustain no damage as a result of the rapid rise in temperature. At the end of the first hour, the thermostat is applied, after which the heat is maintained steadily for about two hours. The oven then is permitted to cool

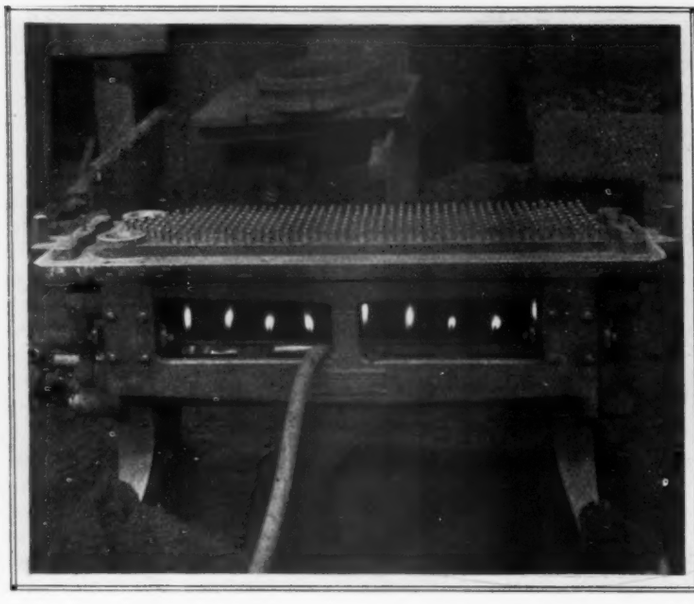


FIG. 4—MOLDING MACHINE AS PROVIDED WITH GAS BURNERS FOR WARMING PATTERN, THUS PREVENTING STICKING OF MOLD TO PATTERN

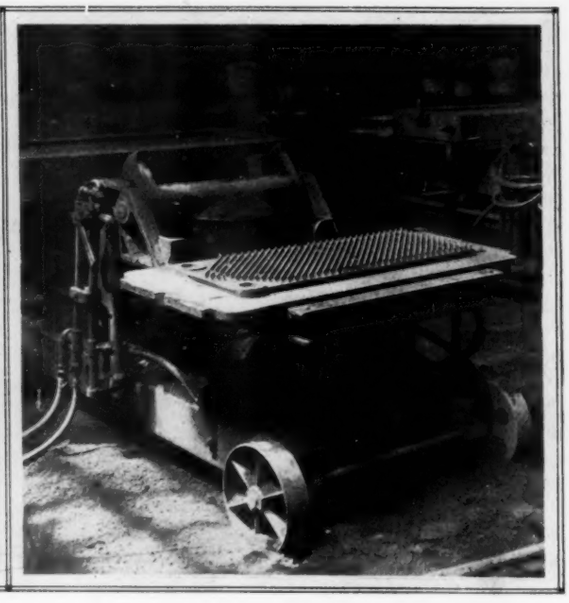


FIG. 5—ROCKOVER MACHINE EQUIPPED FOR MAKING A DIFFICULT INDIRECT RADIATOR MOLD

down gradually during the remaining three hours of the bake.

How the Sand is Handled

The sand, as it arrives at the plant, is riddled through a rocker screen, actuated by means of a cam shaft. The sand then is shoveled into measuring boxes, which have capacity of four cubic feet each. The requisite amounts of linseed oil and water then are added, after which the contents of the boxes are dumped into a paddle mixer of the Standard Sand & Machine Co.'s type. From this the sand is discharged into a hopper, it then being elevated, by means of a chain bucket, to a steel floor overhead. Here the sand is received in wheelbarrows, in which it is wheeled along galleries, on either side of the core shop, and dumped into hoppers which supply the core makers' benches. This method of handling sand is illustrated in Fig. 3. The oil employed in making core sand mixtures is stored in 2 underground tanks having capacity for 10,000 gallons each; from these the oil is brought to the core shop by means of air pressure. At the present time only new bank sand is used in the core department, but plans now are under way whereby the burned sand from the cleaning room will be utilized in part for this purpose. In order to free this burned sand from dust and render it as clean as possible, it will be put through a winnowing process. For this purpose a rectangular tower will be erected into which the burned sand, as it comes from the cleaning room, will be fed through a hopper. The tower will contain steel vanes placed at such an angle to the horizontal that the sand will drop from one to another. Between each two vanes, slots will be cut in the sides of the tower and through these air will be induced. This air will pass through the falling curtains of sand and in this manner the sand will encounter the air as many times in its downward passage as there are vanes in the tower. By this means it is expected that the sand will be rendered clean enough to permit of its use as core making material. From the tower the air and dust will be passed through a dust collector.

Fig. 3 shows a core maker's bench, showing sand hopper, booking ways and venting machine. Each bench is operated by two men, each of whom rams one-half of the core. The two halves then are booked together, and the top half removed, while the core still resting in the bottom half of the box, is slid into the rack of the core truck. All cores are vented by means of venting machines; these are simple hand presses.

FIG. 6—TRANSFERRING A CORE RACK TO THE OVERHEAD TRAM-RAIL, PREPARATORY TO DISTRIBUTING CORES IN FOUNDRY

Fig. 6 shows the type of core racks in use at this plant for transferring cores from the core shop to the foundry. These have capacity for carrying 116 cores each. This type of rack permits the cores to be carried vertically, in which position a radiator core naturally is subjected to less strain than in any other. The use of these racks has aided greatly in reducing the breakage of cores at this plant to a minimum. As shown in the illustration, the loaded rack is transferred to the foundry tram-rail system by means of the traveling crane which commands all parts of the core shop.

The method employed by the company for cleaning core boxes which have become badly gummed from the oil in the sand mixture, is to boil them for 12 hours in a solution composed of five barrels of water to a pail of potash. For this purpose there is a special vat, which is heated by means of steam coils. In the foundry at the H. B. Smith Co.'s radiator plant, the use of stripping plate and flask lifting machines has been applied extensively to the molding of radiator sections. In the case of patterns for indirect radiator sections, considerable trouble was encountered originally, due to sticking of the mold to the pattern. To overcome this difficulty, the company has equipped all of its indirect radiator molding machines with gas burners. By means of the gas flames the patterns are kept warm, and in this manner the tendency toward sticking has been counteracted. The method of installing these gas burners is shown in Fig. 4. Fig 5 shows a rock-over machine used in the production of indirect radiator molds. Several machines of this type have been installed at this plant for making molds in which the weight of the sand is too great to permit of the usual draw and roll-over.

The General Welding Co., Clinton, Ia., has been established by J. T. Killeen and A. C. Coltman, who purchased the interests of W. D. Clark.

Researches in Annealing Malleable Castings

Discussion of the Effect of Silicon, Manganese and Other Elements — Annealing in Molten Brass

By Oliver W Storey

AT THE 1913 meeting of the American Foundrymen's Association a paper was presented by E. L. Leasman on "A Study of the Annealing Process for Malleable Castings". This work was carried out under the author's direction at the chemical engineering laboratories of the University of Wisconsin. In his work Mr. Leasman investigated the influence of the following variables upon the structure of malleable iron.

1.—Packing materials.
2.—Temperature of annealing.
3.—Time of annealing.
4.—Rate of cooling.

From the results obtained in that work the writer has been able to make a more extended investigation of the exact nature of the reactions occurring in the annealing of the white iron. The results of this investigation are presented in this paper. The amount of malleable iron produced annually in the United States exceeds 1,000,000 tons. These statistics show that this process holds an important place in the iron and steel industry. But has it received the scientific attention that an industry of such importance should receive? Judging from the amount of literature available the answer is decidedly in the negative.

Secrecy of Malleable Practice

Owing to the secrecy which has characterized the process in the past, little has been published. The pioneer manufacturer in this country, Seth Boyden, of Newark, N. J., experimented with the process and also recorded his experiments, although he did not discover the underlying principles involved. He deserves special credit since his experiments were made at a time when scientific experimentation on industrial problems was frowned upon.

One of the objects of this research was the determining of the variables which influenced the outside or shell structure.

The four variables mentioned will influence the structure of malleable iron during the anneal. It is understood that the composition of the hard casting is of primary importance in determining the correct annealing temperature, but was not investigated in this research.

The results of the research, as given by Mr. Leasman, may be summarized as follows:—

1.—Packing Materials.
   a. The packing material does not influence the interior of "black heart" malleable cast iron.
   b. The ordinary packing materials do not directly affect the skin structure by chemical action.
   c. A loose packing material, allowing a free circulation of oxidizing gases, will result in a carbonless rim.
   d. A slightly oxidizing atmosphere will result in a steely rim.
   e. A neutral atmosphere will result in a rim having the same structure as the interior.
   f. A slow rate of cooling will tend to result in a rim having the same structure as the interior.
2.—Temperature of annealing.
   a. No annealing could be observed below 670 deg. C.
   b. The higher the temperature of the anneal (above 670 degrees Cent.) the shorter the time necessary to secure a complete breakdown of the white iron.
3.—Time of annealing.
   a. This factor is dependent upon the temperature of annealing.
4.—Rate of cooling.
   a. A fast rate of cooling after annealing results in a steely structure.
   b. The critical cooling range is between 700 and 775 degrees Cent.
   c. If the rate of cooling is sufficiently slow in the critical range all of the carbon will be precipitated.
   d. If the carbon is entirely precipitated in the critical range the rate of cooling below 700 degrees Cent. has little effect upon the iron.

The method used for the production of malleable iron is fairly uniform throughout the United States. The hard white castings, of suitable analysis, are annealed at a red heat for about 60 hours and cooled slowly. The products of various foundries differ slightly. The inner core is the same in all cases, consisting of pure iron or ferrite, throughout which are scattered the globules of temper carbon. The outside or shell structure varies from one of pure iron to a high carbon steel. The practice at each plant will determine this structure.

Discussions of Conclusions

It has been shown by a number of investigators that in case-carbonizing steel the carbon is generally carried to the steel in the form of a gas, carbon monoxide, and that there is no direct union of the iron and carbon when in contact. In this research it was shown that the carbon left the malleable iron as a gas and that the surface was decarbonized as a result. This is the reverse of the carbonizing process. It is also known that while carbon monoxide will carbonize iron, carbon dioxide will have the opposite effect and decarbonize it.

It was shown that all of the packing materials generally used at the present time are inert chemically with reference to the castings. Instead of the chemical influence of the packing material being of importance in determining the skin structure of the malleable, its physical properties, method of packing, atmosphere and temperature of the furnace are important in determining the skin structure. On the other hand, the interior or black heart is not dependent upon the packing materials.

If the hard castings are loosely packed in a coarse material it will be seen that the furnace gases will circulate readily throughout the containers. On the other hand, if the castings are solidly packed with a finely ground material like fire clay, there will be but little circulation of the furnace gases.

If a furnace is run so that there is a large excess of oxygen in the products of combustion, the relative amount of carbon dioxide to carbon monoxide will be large. There will then be a preponderance of oxidizing gases which will decarbonize the surface of the malleable. The same reactions occur if tools are heated in a muffle furnace where too high a percentage of oxygen exists—the carbon

Presented at the Chicago meeting of the American Foundrymen's Association.

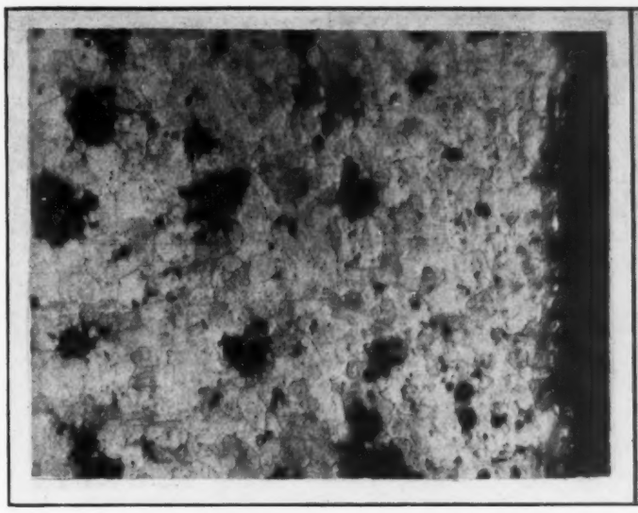


FIG. 1—MICROGRAPH OF MALLEABLE SPECIMEN SHOWING CARBONLESS RIM
(Magnification, 100 diameters)

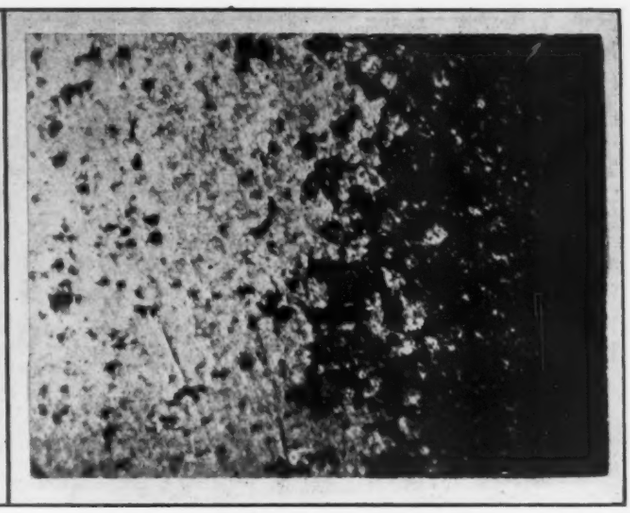


FIG. 2—MICROGRAPH OF MALLEABLE SPECIMEN SHOWING STEELY RIM
(Magnification 50 diameters)

is burned from the surface and the exterior of the tool will be soft.

If an annealing furnace is run so as to obtain a large proportion of carbon monoxide the furnace atmosphere is one which will prevent the decarbonization of the hard castings. In considering these reactions it is well to note that at the lower temperatures 700 to 800 degrees Cent., the equilibrium between the carbon monoxide and dioxide is such that the latter is formed in preference to the former while at the higher temperatures the reverse is true.

If the atmosphere of the furnace is highly oxidizing and the castings have been loosely packed in a coarse material, the surface of the castings will be subjected to a decarbonizing action which will quickly result in a carbonless rim. Such a rim of pure ferrite is seen in Fig. 1.

If the opposite conditions are true, that is, if the castings are covered by a closely packed material and are subjected to an atmosphere which is only slightly oxidizing, only a small amount of carbon will be removed from the skin and a steely rim will result as in Fig. 2.

Where a carbonizing atmosphere is maintained as when the casting is annealed in a case-carbonizing mixture, the rim structure of Fig. 3 is obtained. In this the excess iron carbide remains, resulting in a hard rim.

Specimens Annealed in Molten Brass

Specimens were annealed in molten brass and consequently were not subjected to any gaseous action. These showed a fracture consisting entirely of ferrite and temper carbon which extended to the outside of the specimen. Not a trace of the steel edge was visible.

In commercial work various results are obtained from the steel rim of Fig. 2 to the pure iron of Fig. 1. More often the structure shown in Fig. 4 is obtained. In this the outer rim of ferrite and inner black heart are separated by a layer of steel. This plainly shows the decarbonizing effects of the furnace gases on the extreme outer portions.

In practice it is often desirable to obtain a hard wearing surface while at other times a tough rim is wanted. By varying the conditions of annealing the necessary rim structures may be obtained.

In malleable cast iron the black heart should consist of ferrite and temper carbon with no combined carbon present. In the white casting all of the carbon is present in the combined state as the carbide, Fe_3C. Such a white iron is shown in Fig. 5. The white areas consist of excess iron carbide, while the dark areas of pearl-

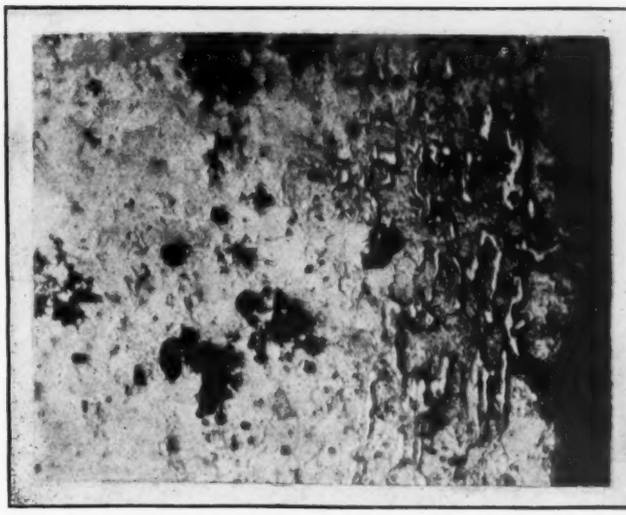


FIG. 3—MICROGRAPH OF MALLEABLE SPECIMEN SHOWING HARD RIM
(Magnification, 75 diameters)

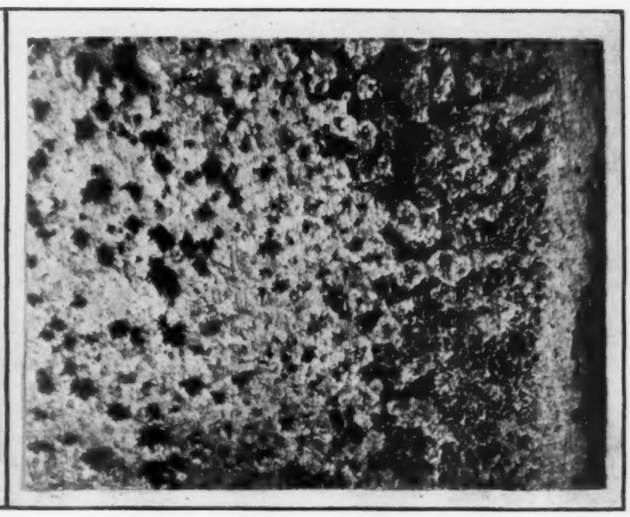


FIG. 4—MICROGRAPH OF MALLEABLE STRUCTURE MOST FREQUENTLY OBTAINED IN COMMERCIAL WORK
(Magnification, 30 diameters)

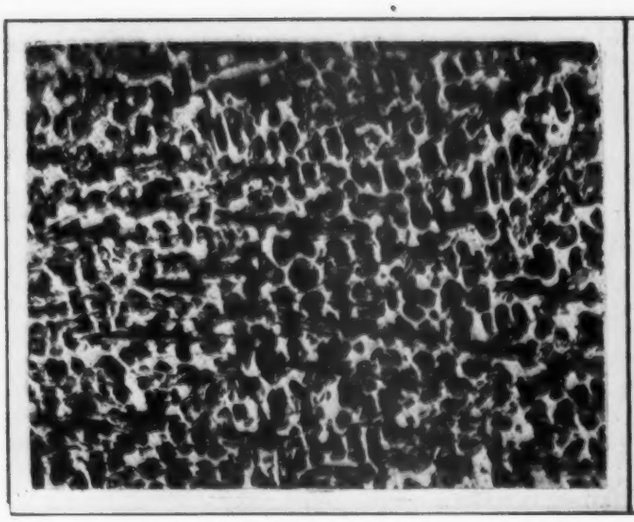


FIG. 5—MICROGRAPH OF WHITE CASTING SHOWING CARBON IN COMBINED STATE
(Magnification, 100 diameters)

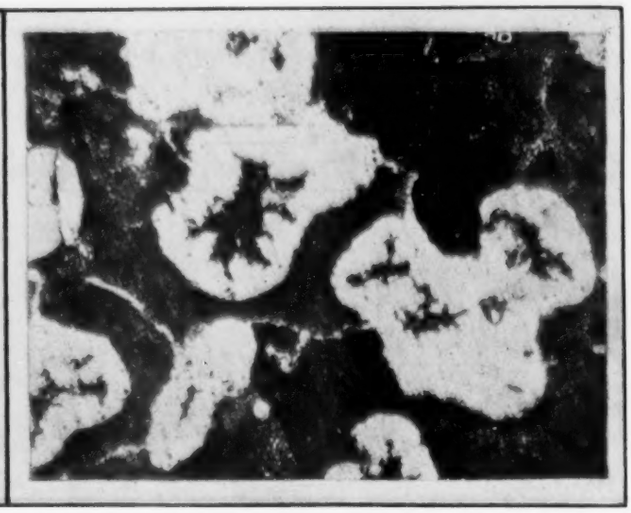


FIG. 6—SPECKS OF TEMPER CARBON SURROUNDED BY PURE FERRITE IN A BACKGROUND OF PEARLITE
(Magnification, 100 diameters)

ite consist of fine plates of iron carbide and ferrite. The annealing process results in a complete breakdown of this carbide into its elements. To accomplish this it has been found necessary to heat the hard casting containing the combined carbon to a red heat, 750 to 900 degrees Cent. The reaction is not simultaneous, but generally requires about 60 hours, after which the iron must cool slowly, covering another long period of time. The time required to bring the oven to heat is immaterial. How long should the anneal require; what is the most suitable temperature; what is a satisfactory rate of cooling and what are the reactions involved?

In malleable iron two elements are present which are important in determining the variables mentioned, namely silicon and manganese. As is known, manganese tends to keep carbon in the combined state and retards the disassociation of the iron carbide. Silicon has the opposite effect.

Silicon also has another important effect as a result of its tendency to prevent combined carbon. The higher the percentage of silicon present the higher the temperature below which carbon and iron may be entirely decomposed. This means that by increasing the silicon content of malleable iron the easier will be the breakdown of the iron carbide. The amount of silicon, of course, is limited by the tendency to form gray iron.

In studying the process it was found that the rate of cooling was important. By cooling rapidly, that is, requiring about 20 hours for the cooling of the specimen, it was found that the resulting malleable was brittle and hard. A microscopic examination showed it to consist of a high carbon steel. The micrograph, Fig. 6, shows specks of temper carbon surrounded by pure ferrite in a background of pearlite. A slower rate of cooling gave the structure of Fig. 7, showing a smaller amount of pearlite while the normal rate gave a structure entirely free from pearlite as seen in Fig. 1.

That this steely structure is not due to improper annealing at the maximum temperature is shown by the following micrographs:

Fig. 8 shows the structure of a test bar which had been annealed at too low a temperature but had been cooled slowly. This shows the dentrites of undecomposed cementite in a background of ferrite with a few specks of temper carbon. The steely structure due to rapid cooling is not present.

If the annealing is not entirely finished the structure of Fig. 9 is obtained showing specks of cementite with a large amount of temper car-

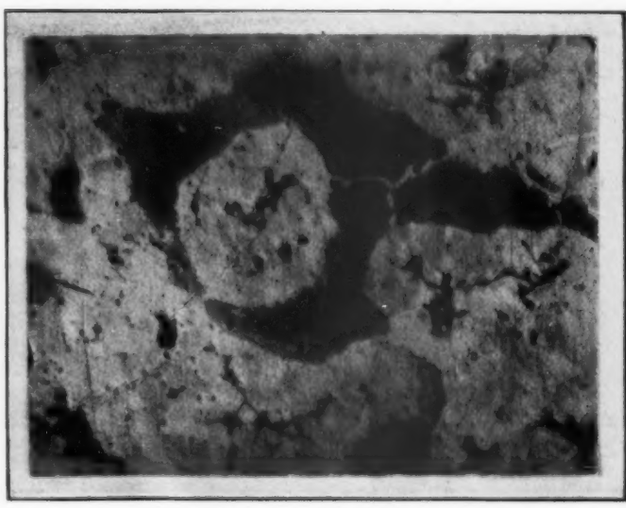


FIG. 7—STRUCTURE RESULTING FROM A LOWER RATE OF COOLING THAN FIG. 6
(Magnification, 100 diameters)

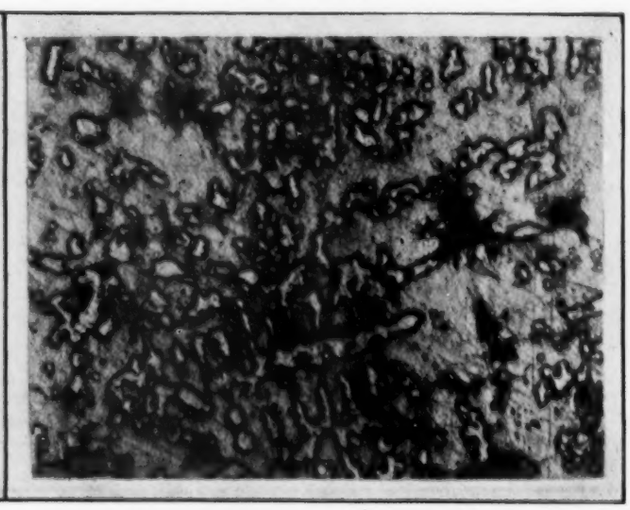


FIG. 8—STRUCTURE RESULTING FROM ANNEALING AT TOO LOW A TEMPERATURE, BUT SLOWLY COOLED
(Magnification 100 diameters)

bon. In the section of commercial iron of Fig. 10 traces of cementite particles remain.

If the cooling is too rapid after improper annealing the structure is similar to that of Fig. 8 except that the background is pearlite and not ferrite.

It is evident that if a steely structure is the result of rapid cooling there must exist a critical range in which this undecomposed carbide breaks down into iron and carbon. If this remaining carbide breaks down in the critical range the largest part is decomposed at the maximum annealing temperature. All of the cementite does not decompose at this high temperature, but only decomposes at the lower temperatures of the critical range.

In order to confirm these deductions and also to ascertain the critical range for the iron in question the following experiments were carried out. Sections of malleable iron which had been perfectly annealed were heated to varying temperatures for different lengths of time and then cooled in the air. In this way the temperature at which the temper carbon went into solution in the ferrite was ascertained by the amount of pearlite present.

Specimens heated to 775 degrees Cent. for two hours did not show any solution of the carbon and were malleable, showing no signs of pearlite. Upon heating to 800 degrees Cent. for five minutes no carbon was found to have gone in solution, but upon heating for two hours a small amount of carbon went into solution. Under the microscope the percentage appeared to be about 0.25. By heating at 850 degrees Cent. for five minutes the entire specimen consisted of pearlite and temper carbon and was brittle. By heating at 900 degrees Cent. the specimen was very brittle. These experiments showed that below 775 degrees carbon was not soluble in the ferrite while at 850 degrees the amount was at least 0.90 per cent. The author regrets that analyses were not made to obtain the exact figures.

The experiments showed conclusively that it would be impossible to obtain a complete breakdown of the carbide at the annealing temperature since the carbon is soluble to a limited extent at this temperature. Also, the breakdown of this residual carbide is not complete except in the range of temperature below 775 degrees Cent. These results also show that malleable iron may be heated to 775 degrees Cent. without danger of forming a steely structure and consequent loss of malleability.

But if the breakdown is complete below 775 degrees Cent. what is the minimum temperature at which this decomposition may occur? The temperature, 700 degrees Cent., is the austenite breakdown temperature and was chosen arbitrarily since above this the iron carbide is in solution while below it occurs free. Chemical compounds are more easily decomposed when in solution and for this reason it was thought that this might apply to the cementite.

Samples of malleable iron were first heated to 900 degrees Cent. for five minutes to insure the solution of a certain proportion of temper carbon. The specimens were then cooled to temperatures varying from 650 to 800 degrees Cent. and kept at these temperatures for varying lengths of time. The results were in accord with the theory.

Specimens heated at 700 to 775 degrees Cent. for from four to five hours showed a structure like the original malleable, temper carbon and ferrite, showing a complete breakdown of the cementite. Specimens heated at 650 and 675 degrees Cent. did not show traces of a breakdown even when annealed for six hours. Annealing at 800 degrees showed a partial breakdown, as expected.

From this data the following conclusions were drawn:

1.—The critical range of cooling is between 700 and 775 degrees Cent.

2.—Below 700 degrees Cent. no decomposition of iron carbide occurs.

3.—All malleable iron must be slowly cooled to 700 degrees Cent. to insure a complete breakdown of the iron carbide.

4.—Increasing the percentage of silicon will increase the upper limit while increasing the manganese will decrease it.

In addition to the experiments upon malleable iron similar experiments were run upon gray cast iron. Similar results were obtained though the upper temperature limits were higher, probably due to a higher silicon content.

By heating at 900 degrees Cent., the structure consisted entirely of uniform pearlite. By heating at 850 degrees for several hours practically no change took place, the structure being pearlite and graphite with areas of ferrite. By heating at 800 degrees for several hours the pearlite in the original casting was broken down completely. The same results were obtained at 750 degrees and 700 degrees but no change occurred upon heating below 700 degrees.

It is noteworthy to remark that the areas of ferrite formed upon heating were much smaller than the original ferrite areas. It is probable that the refining of the grain upon reheating

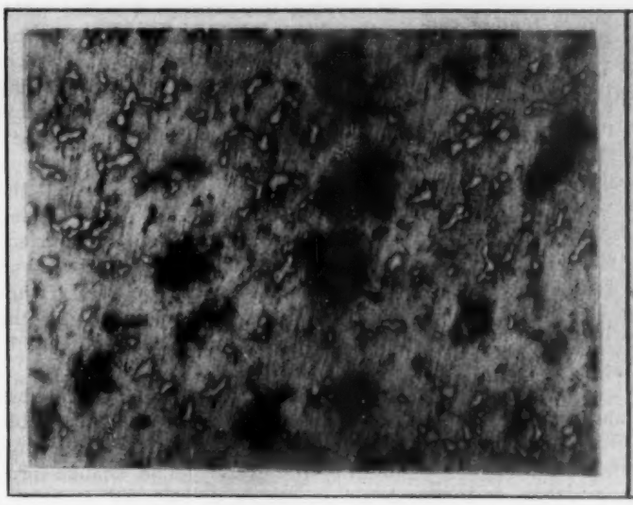


FIG. 9—STRUCTURE SHOWING INCOMPLETE ANNEALING
(Magnification, 100 diameters)

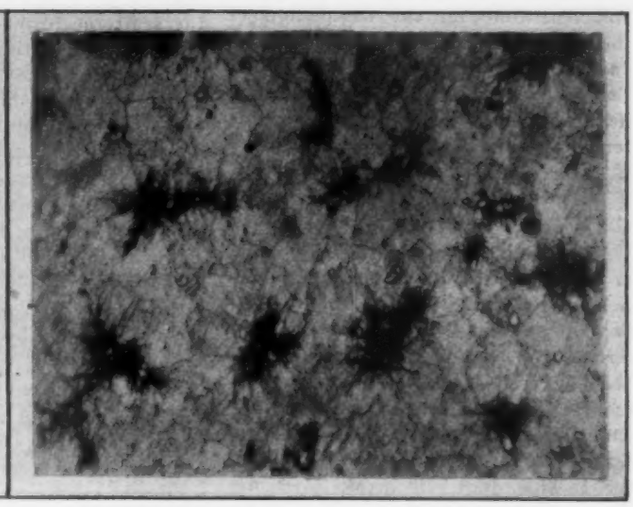


FIG. 10—SECTION OF COMMERCIAL IRON SHOWING TRACES OF CEMENTITE PARTICLES
(Magnification, 100 diameters)

the cast iron through the critical range would cause a fine grained ferrite to form.

In testing the conclusions reached in the above experiments, sections of white iron were annealed as follows:

1.—Annealed at 875 degrees Cent. for 50 hours, cooled quickly to 750 degrees, kept at this temperature for 10 hours and quickly cooled. An excellent malleable structure resulted.

2.—Annealed at 775 degrees for 90 hours and quickly cooled. An excellent malleable structure was obtained but traces of cementite remained showing that this time was too short at this temperature.

3.—Annealed at 875 degrees for 50 hours, cooled quickly to 650 degrees, kept at this temperature for 20 hours and quickly cooled. A steely, brittle structure resulted.

From the result of these annealing experiments the critical range is shown to be between 700 and 775 degrees Cent. and that it is necessary to give sufficient time for the completion of the carbide breakdown in this range. In all of the experiments it was found that the best results were obtained if the cooling was slow through this temperature range.

Reactions Which Take Place in the Annealing Process

As a result of the investigation some progress was made in the determination of the reactions resulting in the breakdown of the iron carbide to form ferrite and temper carbon. It has been generally supposed that the iron carbide broke down directly at the annealing temperature. In this research the results seem to show that the carbide does not break down directly, but decomposes only when in solution in ferrite as austenite. It must be understood that the author does not wish to imply that iron carbide will not decompose directly, but that in this case the iron carbide in solution will decompose more readily than that in the free state.

The following data are significant in determining the reactions resulting in the malleable iron structure:

1.—When malleable is heated for too short a time or too low a temperature and slowly cooled the structure consists of ferrite, cementite and temper carbon, Fig. 8.

2.—Correct annealing results in a structure which consists entirely of ferrite and temper carbon, Fig. 1.

3.—Cooling too rapidly after correct annealing at the maximum temperature results in a structure of temper carbon surrounded by ferrite, in turn enclosed by pearlite, Fig. 6.

4.—By annealing at too low a temperature and cooling rapidly the specimen consists of areas of excess cementite surrounded by pearlite and small particles of temper carbon surrounded by ferrite.

5.—At 800 degrees Cent. the temper carbon begins to go into solution.

6.—Above 700 degrees the carbide breaks down completely, but no decomposition occurs below this temperature.

The white iron consists of pearlite and cementite. Since the pearlite consists of plates of ferrite and cementite the entire white iron has two constituents, ferrite and cementite.

When the hard casting is heated to be annealed the constituents of the pearlite go into solution as austenite at 700 degrees Cent. At the annealing temperature a portion of the excess cementite also goes into solution. When the breakdown occurs does the excess cementite or does that in solution as austenite decompose first?

If the excess broke down first the reaction should show some free graphite scattered in areas of cementite. Instead of a uniform breakdown and the scattered formation of temper carbon these cementite areas grow smaller as though they were being gradually dissolved while the temper carbon forms in large patches. There is no evidence of a direct decomposition of the excess cementite.

When the cementite in the austenite decomposes it deposits the temper carbon while the ferrite is liberated. This ferrite dissolves more of the excess cementite. The nucleus of temper carbon hastens the breakdown of the carbide.

In specimens which have been imperfectly annealed and show areas of excess cementite, Fig. 8, the cementite adjoining temper carbon areas is much smaller than that farthest away. The area directly about the temper carbon is usually free from cementite. This would result if the cementite dissolved as austenite is decomposed. Since the ferrite is liberated at the temper carbon, the concentration of this constituent would be greater there and the excess cementite in the immediate vicinity would be more quickly dissolved than that farther away.

The decomposition of the iron carbide in the austenite is not complete at the annealing temperature, 850 to 875 degrees Cent., but is complete at about 775 degrees Cent. The lower the temperature the less stable the cementite, depending upon the silicon and manganese present. But below 700 degrees this rule does not hold since the iron carbide is again stable owing to the dissociation of the austenite into its constituents as pearlite. The carbide is not in solution below 700 degrees and is again stable, as was shown in the experiments.

Galvanizing Malleable

(*Continued from page* 470.)

tank. As soon as it is seen that the sand has loosened, the castings are then thoroughly washed in water. After this treatment, and for the purpose of making the metallic surface take the zinc quickly and firmly, and to remove any rust that was not removed by the sulphuric acid treatment, the castings are treated for a few moments to a hydrochloric acid bath; one of acid to two of water. This treatment removes every trace of rust from the surface of the casting, forming a thin layer of iron chloride on it, which prevents the sensitized surface from oxidizing while drying and preparatory to dipping. After drying, the castings are ready to dip, though in some factories they are plunged into the bath before they are wholly dry.

The precaution should now be taken of dipping the castings into hot water rather than cold, as the latter treatment has the effect not only of lessening the luster of the coat and making it rough, but worse than all else that could happen, it deteriorates the metal of the casting, spoiling its ductility and toughness. In some cases the extra precaution is taken of putting a small layer of oil on the surface of the hot water, but as far as I have been able to discover, if hot water is used, and particularly if the zinc bath has not been too highly heated, no oil is needed.

I have recently made a number of experiments of heating malleable iron to certain temperatures and cooling in cold water. The change produced in the structure will form the subject of another paper. So I will simply state at this time that the changes are very marked, and that such treatment destroys both the toughness and ductility of the iron, in other words, spoils the castings. Not only must the zinc bath be kept well within the temperature necessary to just do the work and no more, but the water application must be carried out with hot water, or the result will be disastrous.

The Independent Pneumatic Tool Co., Thor building, Chicago, has issued a new four-page circular describing various types of pneumatic tools suitable for use in foundries, machine shops, etc. Riveting hammers of various sizes are illustrated, together with drills, air hose, etc. Particular attention is given a description of a long-stroke, one-piece riveting hammer equipped with a safety trigger which is said to prevent accidental discharge.

Operating a Foundry on a Scientific Basis---II

Second in a Series of Articles—This Installment Covers Thoroughly the Use of Symbols

By Frederic A Parkhurst

IN GENERAL, foundry equipment (including small tools) is found in a poorer state of repair than obtains in the majority of the other trades. The reason for this may be explained as follows. The equipment itself, except perhaps metal patterns and core boxes, is as a class rough in appearance and less expensive in construction. The general shop conditions surrounding its use tend to further make it appear less valuable than it is. There are few finely finished parts. Adjustment features are too often over-looked entirely; and in some cases the maker through his design seems to invite carelessness in this respect.

The real cause for the average low standard of efficiency that is found in foundry apparatus, is directly traceable to the large percentage of unskilled help employed in the operation of foundry machines. They are not mechanics in the sense we consider a machinist, pattern maker or tool maker, though perhaps competent enough as far as the "technique" of their own particular work is concerned.

A careful study of these men at their work will reveal a deplorable ignorance of the use of the most common tools such as a hammer, wrench, spanner, screw driver, etc. A crow bar in a foundry is often a scarce article yet you can walk through the average foundry as often as you like and seldom fail to see the shovel doing duty in its stead. The uses to which foundrymen can put a shovel are too numerous to mention; hence, a great expense for shovels. It is easier to knock the handwheel off of an air valve and leave it turned on full blast than to keep shutting it off. Here we find a large waste of compressed air, one of the most expensive forms of power.

Now molding machines are as a class expensive enough when in good operative condition and not tying up production because they will not operate. But when they are abused by ignorant help, allowed to become clogged with sand, fed by leaky air lines (caused by improperly clamped or cut hose), inaccurate in operation due to worn parts, resulting in shifts or "torn up" molds, we then find an enormous direct and indirect loss of many dollars each day they are in use.

The loss due to faulty machines and tools is far reaching. Losses of production, sometimes involving many men is a big item in itself. Add to this the loss in profits on a realizable production you don't get. Also consider power wasted, interest on expensive patterns, non-productive plant, increased defective loss and it seems we have too much already. One more even greater item must be included, however, before our list is complete; viz.: the moral effect of such a condition on all the men employed.

To prevent all of these losses requires constant care and close inspection. An ounce of prevention is worth a pound of cure. A maintenance force of skilled mechanics is apparently an expensive luxury. In net cost, however, such supervision is one of the biggest investments. It is just as important to keep foundry equipment operative as it is to take good care of the machines in a first-class machine shop. Motors particularly soon give trouble due to the excessive dust always prevalent to a certain extent, no matter how well the work rooms are ventilated.

The maintenance foreman should be considered as important in the foundry as he is in business. Give him sufficient help, put him in charge of all the equipment and hold him directly responsible for it. He must keep in close touch with all conditions affecting the operation of machinery and have the authority to make immediate repairs as fast as the first indication of such a necessity presents itself. Anticipation of such a condition is necessary. Don't wait until it develops into a *real* trouble.

When equipment is finally whipped into shape and the methods bring practically all employes under bonus, it will be easy to maintain machinery in first-class condition. As the workman is principally engaged to operate (not repair) equipment, he should not be expected to waste his time and the firm's money by doing a kind of work that he is not fitted for. Before leaving this part of the subject, attention should be called to the care and operation of core ovens. Here we have equipment which if slightly out of order will greatly increase the cost of drying cores. Forcing the ovens will result in burned cores. Improper drying results in damp cores; and "blown" cores spoil castings. Not enough cores ties up production and we are back again to the subject of limited output.

Pyrometer control of oven temperatures means not only a saving in fuel, but a greater saving due to "even" drying, fewer burnt cores and minimum delay in getting cores through the ovens. Here again we have the advantage of periodical inspection and repairs *before* trouble begins.

Accurate data on oven duty will divulge many sources of loss in efficiency. The time study will show a wide variation in the time it takes to dry one core as compared to another.

Proper maintenance and frequent inspection of equipment effects another even greater saving, greater at least from a humanitarian desire to reduce to a minimum the chance of serious accidents. Many comparatively recent laws tend to greatly promote the care and guarding of machines. These laws are in themselves insufficient. We need local care and minute supervisions.

We must not leave the workman entirely to himself in this respect. Some men are notably careless and reckless. It is part of their nature. Such men are not protected under the new laws, "contributory negligence" or the natural hazards of a trade being no longer a defense for the master. From the foregoing it can readily be seen that all the planning and supervision we can bring to bear on this subject is more than "worth while". The proper care and safe-guarding of gears, belts and wheels should be the special care of a functional boss. It will be cheaper in the end, the psychological effect is great and the net results obtainable from a given plant will be much larger. It will be *producing all of the time.*

The prime object of any system of symbolizing is to provide a char-

A paper presented at the joint session of the American Foundrymen's Association and the American Institute of Metals, Chicago, Sept. 9, 1914.

acter which will assist in the prompt identification of any unit. The second object is to use a character flexible enough to include all branches of a business within its scope. The present opportunities for the use of a practical, comprehensive scheme of symbols are limited.

The author maintains, adverse criticism to the contrary, that a symbol is an identification mark first and foremost. The character must positively differentiate one article or unit from some other. If a simple and not too cumbersome symbol could be devised which would instantly tell by its form or character what is represented, it might be ideal, but so far all efforts along such lines have proved impractical. If we know the number of a house on a given street, for example, 360 West Fifty-ninth street, it is not necessary to know whether the house is an old mansard design, an early colonial type, or a modern tenement structure in order to identify it. The address enables us to direct one to this house or find it ourselves with a minimum of effort. The symbol should enable one to identify an article or unit with just as little effort. So, bearing in mind the essential factor of identification, it is obvious that the greatest practical use will be obtained from that scheme of symbols which is founded upon the simplest rules, with as few characters as possible and which has the least variations.

The different schemes of symbols which have been developed from time to time may be classed under the following general headings:

Dewey Decimal System.
Mnemonic System.
Arbitrary System. A modification of this might be called the Group System.

The Dewey decimal system is undoubtedly the most complete and highly perfected in theory of any, and, as the name indicates, is a combination of figures and periods giving a symbol of an almost unlimited number of characters. This use of figures and decimal points offers an infinite number of possible combinations. The system carefully worked out will provide a number symbol applicable to every conceivable thing past, present or future. It is, however, in no way suggestive nor practical for general use, and a voluminous key is necessary even to interpret the symbol.

The Mnemonic system, as its name indicates, was devised with the purpose of supplying a symbol which should be suggestive and which would indicate the object that it was intended to identify. In theory, it is an excellent system and could, perhaps, be applied in a limited way to a comparatively small number of units so as to be comprehensive and valuable. For general use, however, the system utterly fails to meet the end for which it was designed. It is impossible to devise a symbol on the Mnemonic plan which is generally applicable to units of widely varying kinds of business. The Mnemonic symbol consists of combinations of letters and figures with the occasional use perhaps of a period or a dash. If the attempt is made to apply this system very generally, it soon becomes apparent that the result is a symbol of a great number of characters, sometimes running to 12 or 15, and one which in itself is in no way suggestive. Again a voluminous index or "key" becomes necessary.

There are a great many combinations of letters representing general classifications which have been developed in connection with the Mnemonic symbol system. The result is that five, six or seven letters, or combinations of letters and figures, may be necessary before one gets to the number identifying the one particular piece in a class from its next-door neighbor. A further disadvantage of a Mnemonic scheme is that a combination of letters and figures is much harder to write, read or remember, even for a few minutes, than a comparatively arbitrary one, providing this combination of letters and figures consists of more than several characters. SHVXRI is much harder to read and to retain in the mind than 24321X or 243211. If two pieces just alike are symbolized, one with the first of the above symbols and the other with the latter, the one bearing the plain number can be more easily and quickly identified.

Another argument often brought up by advocates of the Mnemonic system is that when one sees a piece bearing a symbol or sees the symbol in print, it is desirable to know what the piece is so that it can be located. In practice, however, this is not so for several reasons. One is, that should a stray and strange piece with a symbol attached be found, it would be necessary in any case to refer to the symbol index. This would be true whether the Dewey, Mnemonic or Arbitrary system was in use. Obviously, then, the simplest and easiest system to remember is the best.

In the majority of cases the use of the symbol is either in connection with papers or documents, or one is looking for a piece of which the simple name is known. Further to illustrate this point, suppose that the order or material list referred to a "right support for an 18-inch x 10-foot motor-driven engine lathe"; the simple name of the piece would be a support, which one would identify by its symbol. The symbol in this case answers the same purpose as a number of a house on a certain street. In practice, as above stated, it is very seldom that there is any great material advantage, especially in connection with piece symbols, in having the symbol represent the character of the piece involved. After all is said and done, this is an absolute impossibility without reference to an index.

Some of the most satisfactory and easiest forms of identification in use are some of the old systems of "piece numbers", which are nothing more or less than arbitrary numbers which have been given to pieces as they were designed or became merchandise. Another very old scheme is that of grouping pieces by classes, as E112, to represent a part number 112 for an "E" type machine. Modern practice, however, especially in connection with the higher developed forms of management, has made it desirable to utilize a scheme of symbols for many and various purposes. The writer believes that the simple and comparatively arbitrary form of symbol is by far the best.

Department Symbols Adapted for Foundry

The scheme of symbols, outlined below, is an endeavor to illustrate to what advantageous use symbols can be employed. It also gives a key to a practical set of symbols which can be modified or expanded to suit any kind of manufacturing or jobbing business. It will be noted in studying these symbols that there is a certain element of suggestiveness about them as far as the different classes of symbols are concerned. The arrangement of the numerals, however, can be purely arbitrary, except that, of course, it is wise to be always systematic and try to symbolize in order of age, size or alphabet, as the case may be. The scheme may be classed as one which is purely arbitrary.

Let us assume that the first set of symbols will be used to represent departments. Bearing in mind that it is desirable to have as few characters as possible in the symbol, let us start by arranging the departments in their general order, working from the administrative heads down to the manufacturing departments of the shops,

and allotting a number and letter to each as follows:

1A—Accounting Room
1B—Local Sales Dept.
1C—Core Room No. 1
2C—Core Room No. 2
3C—Core Room No. 3
4C—Core Room No. 4
5C—Core Room No. 5
6C—Core Room No. 6
1D—Delivery Dept.
1E—Employment Bureau
1F—Furnace Room (Class A and C)
2F—Furnace Room (Class B only)
1G—Garage
1H—Heat, Light and Power
1I—Inspection Dept.
1J—Janitors and Watchmen
1K—Carpenter Shop
1L—Planning Room
1M—Molding Room No. 1 (Class A)
2M—Molding Room No. 2 (Class C)
3M—Molding Room No. 3 (Class C)
4M—Molding Room No. 4 (Class C)
5M—Molding Room No. 5 (Class B)
6M—Molding Room No. 6
1N—Knockout (Class A and C)
2N—Knockout (Class B)
1O—Time Keeping
1P—Pattern Shop
2P—Pattern Storage
1Q—Sand Mixing
1R—Receiving Room
1S—Shipping
1T—Trimming Room (Class A and C)
2T—Sand Blast (Class A and C)
3T—Trimming Room (Class B)
4T—Sand Blast (Class B)
1U—Machinists

On this basis any letter of the alphabet preceded by a numeral indicates a department.

2U—Brass Finishing Department
3U—Tool Room
1V—Forge Shop
1W—Welding Department
1X—Stores—Metal
2X—Stores—Lumber
3X—Stores—Iron, etc.
4X—Stores—Miscellaneous
5X—Stores—Sand
6X—Stores—Oil
7X—Stores } Available for new
8X—Stores } Stock divisions
9X—Stores }
10X—Stores }
11X—Move Material Foreman
1Y—Yard Department
1Z—Maintenance Department

General and Departmental Expense Symbols

The expense symbol consists of the letter "X" (or "XX") followed by a numeral running from 1 up. The following list gives an idea of the general indirect expense symbols as they may be adapted to a foundry. As these items are items which can't be distributed departmentally but are general expense, we use two letters "XX", as follows:

XX1 Salary of managers, superintendents (including Superintendent, Core Superintendent, and Mold Superintendent)
XX2 Clerical wages
XX3 Other labor
XX4 Supplies
XX5 Maintenance of buildings and structures
XX6 Maintenance of equipment, furniture and fixtures
XX7 Care of
XX8 Miscellaneous expense, not supplies
XX9 Miscellaneous small tools
XX10 Experimental and test expense
XX11 Fuel
XX12 See 1HX12
XX13 See 1HX13
XX14 See 1HX14
XX15 See 1HX15
XX16 See 1HX16
XX17 See 1HX17
XX18 Advertising
XX19 Traveling expense (operating only)
XX20 See IGX20
XX21 See IKX21
XX22 See 5CX22, 5MX22 and 2TX22
XX23 Injuries to employes
XX24 See IWX24
XX25 Inventory expense
XX26 See LFX26
XX27 See 5CX27 and 5MX27
XX28 See IHX28
XX29 See IHX29
XX30 Freight and express
XX31 Defective and damaged castings expense
XX32 All bad work expense exclusive of XX31
XX51 Legal expense
XX52 Insurance, (monthly entry)
XX53 Taxes, (monthly entry)
XX54 Depreciation, (monthly entry)
XX55 Interest expense, (monthly entry)
XX56 Metal shrinkage, (monthly entry)

Departmental expense symbols consist of the letter "X" followed by a numeral. This symbol X1 and upwards is preceded in every instance by the department symbol. For example—1AX1 represents an expense symbol for department 1A; likewise 10X10 or 1PX5 indicates certain expense items for the departments indicated by the first two characters of the symbol.

It will be noted that the departmental items of expense cover exactly the same subjects, number for number, the only difference being in the departmental symbol preceding the letter "X". Some departments may not use some items required for another department. A typical list of departmental expense symbols is given herewith to indicate the sub-divisions. The list given below applies to five core rooms in one large foundry. A similar list is made out for each department listed above in the list of departmental symbols, as follows:

5CX1 Foremen's wages
5CX2 Clerical wages (including shop time clerks)
5CX3 Other labor
5CX4 Supplies
5CX5 Maintenance of buildings and structures
5CX6 Maintenance of equipment, furniture and fixtures
5CX7 Care of
5CX8 Miscellaneous department expense
5CX9 Miscellaneous small tools
5CX10 Experimental and test expense
5CX11 Fuel
5CX12
5CX13
5CX14
5CX15
5CX16
5CX17
5CX18
5CX19
5CX20
5CX21
5CX22 Sand
5CX23 Injuries to employes
5CX25 Inventory expense
5CX26
5CX27 Replacement of stock chills
5CX28
5CX29
5CX30
5CX31 Defective and damaged castings expense
5CX32 All bad work expense exclusive of 5CX31

Order and Job Symbols

General orders and job numbers may be designated by alloting to each of the different classes a suggestive letter which is followed by a numeral representing the sequence of the order or job. The following classification is offered as a guide and to illustrate this point.

Orders are indicated from O1 and upward by numerals. In the event that it is desirable to divide the order into items, either to separate different kinds of work or to get subdivisions for cost or other purposes, each item should be identified by the addition of a small letter a-b-c-d, etc., depending on the number of items involved. For example, O1260a-d would indicate an order having four items, and each of these items would be known as O1260a, O1260b, O1260c and O1260d.

Contracts are designated C1 and upward by numerals. Should a contract be subdivided into four items, as above explained for orders, the contract as a whole would be known as C1260a-d and the several items identified by the small suffix letters in the same way as order items.

Stock is marked L1, L2, etc. Stock jobs would only be issued for one or more pieces of a kind on which individual costs were to be obtained; in every case stock jobs are only made for stock.

Miscellaneous is indicated by M1, M2, etc., representing jobs for merchandise, etc., built for some specific order, but which may be divided before completion to apply on some customer's order other than the one which they were originally started. These jobs may be divided into items, as explained above, for (O) and contracts (C).

Plant is indicated by P1, P2, etc. These jobs are only used for work for plant and for some specific equipment which is made as a whole on one plant job. As many plant jobs are issued as are necessary to get the required individual record of their cost.

Factory is indicated by F1, F2, etc. F jobs are handled exactly as are plant jobs—refer to the preceding paragraph.

Plant Equipment

A very common and satisfactory system of symbols for plant equipment is one composed of a letter followed by a numeral suggestive of the kind of machine or tool to which the symbol applies. In some series of symbols it may be desirable to have the numeral follow the letter rather than to precede it, so as to clear other existing sets of symbols. There is no further particular reason for using one method instead of the other, though it is surely more correct to say "lathe 5" (Symbol L5), than to say "5 Lathe" (Symbol 5L). Both methods are in extensive use and answer the purpose. Arbitrary num-

bers for machines systematically arranged answer every purpose, as they also do for piece symbols. To identify equipment in each of several plants run by the same company, a plant letter may precede the equipment symbol. DB11 would indicate boring mill 11 in the Detroit plant or CB11 would indicate boring mill 11 in the Cleveland plant.

By combining the machine symbol with the symbol of the department in which the machine is located, we have a very complete and suggestive scheme of symbols which will not only identify each machine by type, but which will also show at once where it is located.

Machines (and other tools) are ordinarily grouped as follows:

B	Boring Machines
D	Drilling Presses
G	Grinders
K	Keyseaters
L	Lathes
M	Milling and Gear Cutting Machines
P	Planers
S	Shapers and Slotters
V	Vises
W	Woodworking Machines
Z	Miscellaneous Small Tools

In developing a symbol on this system, 1PW1 would indicate a woodworking machine No. 1, located in pattern shop; or symbol 1KW6 would indicate a woodworking machine No. 6, located in the carpenter shop; or 1UM12 would indicate a milling machine No. 12, located in the machine shop.

It will be noted in the examples just cited that a character is made up of a letter followed by a numeral to form one symbol, which added to the symbol for a department makes a combination symbol, giving us a direct reference, not only to the piece but to the location as well. There will be no other similar symbol so that we have no possibility of duplication or confusion.

By referring to the list given above, it will be seen that Z is a characteristic letter for miscellaneous small tools. This classification also includes forged tools for lathes, planers, boring machines, shapers, slotters, etc., but ordinarily it would not include standard commercial drills, taps and reamers. From the standard grinding charts for the tools mentioned as belonging to this Z class, they would be numbered systematically as far as possible, but later arbitrarily. This number, of course, following the letter Z. As many of these tools will have a drawing, the symbol will be constructed as explained below for "Pieces"; as an example, D-Z 164. The D indicates the size of the drawing, Z that it is a tool and 164 its number. This number can be followed by the symbol 3U the symbol for tool department—in cases where it is desirable. Theoretically, at least, all of these miscellaneous tools belong to the tool department and are checked out from there to the men and machines.

To illustrate further the advantage of such a system of symbols in connection with expense accounts, the following example is given. As explained in a former paragraph, subdivisions of departmental expense would be indicated by an X symbol following the departmental symbol; 1U stands for machine shop, and if the subdivision of this departmental expense for miscellaneous repairs or maintenance of machines is 6, the expense charge would primarily be 1UX6. Should this expense, however, have been incurred directly by a machine in this department (say a boring machine No. 11, symbol of which is B11), the charge would be reported as 1UX6B11. In this way the charge is brought directly to the department and machine which actually incurred the expense. Grinding and maintenance of small miscellaneous tools are not directly chargeable to any particular tool. Such jobs are a toolroom expense and the charge would be 3UX9.

Piece Symbols

Piece symbols have caused more argument than perhaps any other set of symbols in use in modern organization work. As stated above, the writer, after years of experience with various forms of symbols, prefers the arbitrary number system to all others. A plain number, however, without letters is not sufficient for two chief reasons: first, that the plain number which is not accompanied by a letter is liable to conflict with other numbers; the second, that changes or modifications of a piece must be indicated in such a way as to be absolutely apparent at a glance.

All pieces should be symbolized without regard to whether they are to be made or purchased. All pieces are to have the same kind of symbols, consisting of a letter, numeral and the letter X (even though special and never to be used more than once). The reason for starting the symbol with the characteristic letter will be explained later under Drawing Symbols. All commercial articles, such as standard bolts, screws, nuts, taper pins, keys, wrenches, oil cups, washers, etc., should be symbolized, first commencing at 1X after the character letter. This should be systematically done and a symbol provided for each kind and size of each article as listed in the maker's catalog, whether the article happens to be in demand at the time or not; it may be used later.

The parts made by the firm should next be symbolized, taking for the first piece the next unused number. This should also be systematically done by taking parts in the alphabetical order of their names and also in the order of their size. For example, if the first machine is "A Type", all A parts should be symbolized first; if the "A Types" consisted of say six sizes, the first sized piece (alphabetically) would be symbolized first and the other five sizes of this piece would take the next five consecutive numbers. After taking all pieces of all sizes in the "A Type" the next type (B for example) would be treated likewise and so on through all the different types and sizes. This explanation is made on the supposition that there are already existing machines and parts in use to be symbolized.

New parts should be symbolized in the order of their coming into use, and arbitrarily. It is easier in fact to be methodical in the arrangement of symbols than to go at it in a haphazard manner. A step in the right direction can be taken at the time the machine is being designed and while the material list is being created. The parts should be arranged systematically on the material list in groups and in the order in which they will be required by the shop, either by kinds of material or kinds of work, depending on the business involved.

It is a very good scheme in symbolizing new parts, to arrange them so that all iron castings, for instance, come together; after which may come bronze castings, steel castings, forgings, miscellaneous pieces, etc. Each new piece is symbolized by the use of the next unused number, but if one major piece requires one or two less important parts to make it complete, such as caps or brackets, these would naturally take the next following numbers in the order of their importance before symbolizing a new piece. It should be borne in mind that the foregoing is in no way essential to the scheme of symbols involved, but simply a small detail tending to a methodical way of doing a thing that is preferable to an unsystematic method.

Having provided for the piece and symbol proper, it becomes necessary to provide for alterations or changes to pieces which have been already symbolized. There are two chief changes to be provided for; one, that which is made to a pattern before a casting is made, and the other,

which is simply a change in the dimension or shape, due solely to machining, where a standard casting is used. It is conceivable that a standard pattern of a wheel or gear, or some such common and regularly used piece, might be made slightly "special" a great many times by a slight alteration in the pattern. As there may be no limit to such possible changes, a numeral is added to the piece symbol after the suffix letter X. If a piece is to be made by an alteration to an existing pattern, say D1120X, a new piece made from this altered pattern would be known as D1120X1. The numeral after the X is to show that the pattern D1120X was altered, and indicates at once that a wholly new pattern is not required. The symbol, of course, originates in the drafting room, as also does the design of the pieces. It is good practice to use existing patterns as far as possible, if the changes are not such as to permanently injure or weaken the pattern for use as originally intended. If this same pattern later had some other alteration or addition to make still another piece, the new piece would be known as D1120X2.

Where a change is one due entirely to a difference in machining a standard rough piece or casting, a letter is added to the end of the symbol after the suffix letter X, to indicate such a change in machining. A letter is used because it is not likely that the same piece would be machined in more than 26 different ways. Suppose, for example, we have a standard casting symbol D1120X, the only change required for a new piece being in the machining of it; the special piece would be symbolized D1120XA, the additional suffix letter A indicating a change only in the finishing. We know at a glance that the rough piece D1120X is the one to be used and the letter A indicates that it is the first machining change. To further illustrate this point, a blank bolt might be known as A621X. If threaded, say 3½ inches, it would then be A621XA; if the same blank was used for a bolt faced under the head or otherwise different from above, it would be known as A621XB. As above stated, it is not likely that any one rough part would be machined in more than 26 different ways.

In the event that we have a standard pattern from which we are to make two special pieces by altering the pattern, making two castings alike, and then machining one slightly different from the other, one of these pieces would be known as D1120X2 and the other as D1120X2A.

This scheme, as worked out in practice, has repeatedly proved that there is a distinct advantage in having the above-described combination of numbers and letters as suffixes to the original piece-symbol suffix X. Of course, all piece symbols must be properly indexed in the piece-symbol index. This piece-symbol index is a double one on the card system—one set of cards being arranged numerically from 1X up, though in general groups, they are arranged alphabetically according to the prefix or characteristic or letter. In a numerical index, if we are indexing piece D1120X, it will, of course, come in its proper position after D1119X. Should there be a modification of this piece, known as D1120X1, the card for this piece will follow the card D1120X. If there is still another card D1120XA, this would come in behind the last mentioned card. The following arrangement will show how the alphabetical index is arranged.

Arms	A Type	1 size
		2 "
		3 "
		4 "
		5 "
		6 "
	B Type	1 size
		2 "
		3 "
		4 "
		5 "
		6 "
	C Type	1 size
		2 "
		3 "
		4 "
		5 "
		6 "

There is a method of symbolizing pieces, known as the group scheme, which has also worked satisfactorily in practice to a limited extent. This scheme, however, has the same disadvantages as the Mnemonic symbol system, namely, that it is more or less restricted and cannot be universally applied to any kind of business. A group scheme with a characteristic letter or letters followed or preceded by a numeral, adapted to one kind of business will not fit another line.

The trouble in developing any but a purely arbitrary symbol system is that the tendency is to work toward the Mnemonic feature by trying to make the symbol suggestive. This scheme is absolutely impracticable if

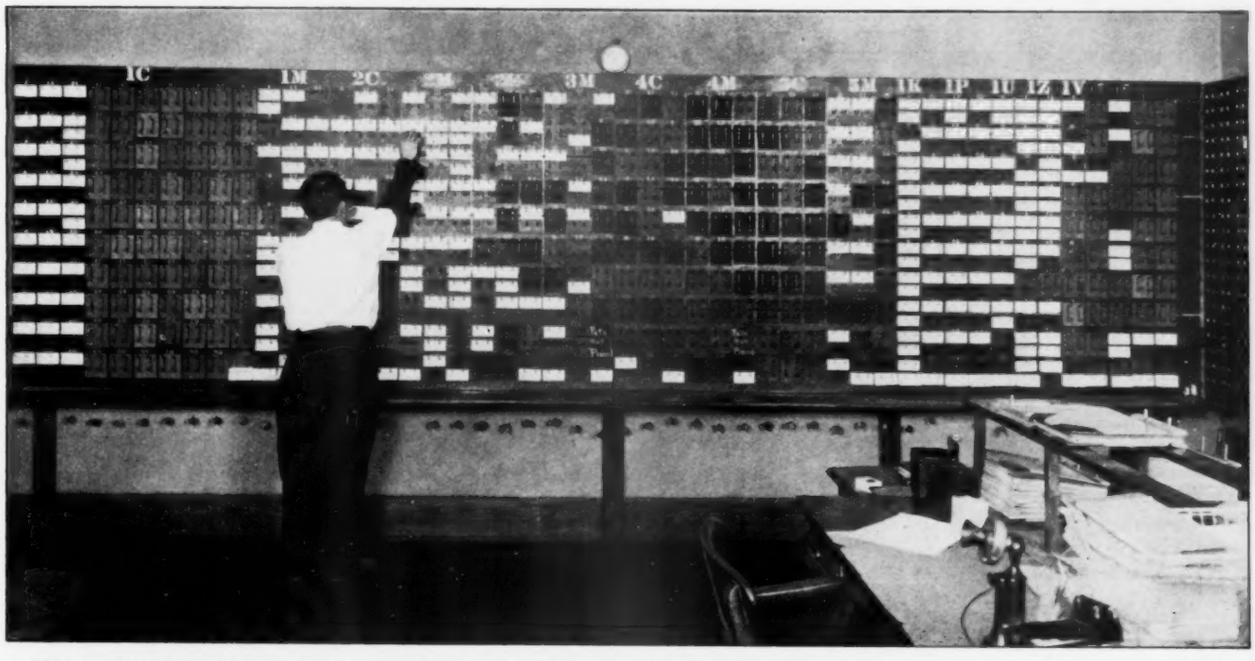


FIG. 5—SYMBOLS ARE USED TO INDICATE ALL THE MOVEMENTS CONTROLLED THROUGH THE PLANNING BOARD

carried to any great extent. The tendency is toward complication, and while the symbols may be shortened by this method perhaps by one character, this slight saving is of no consequence and it ceases to exist if there is any great variety of pieces. Most any simple piece symbol will soon reach five characters, not including the suffixes added to represent alterations or variations from standard, such as have been described.

Jig and Special Tool Symbols

All special tools, jigs, templets, etc., should be symbolized to indicate without chance of error the pieces or parts for which they were specially designed. The simplest way to do this is to take the piece symbol, such as D1120X, D1120X1 or D1120XA and add to this symbol a small letter. The principle involved will simply show that there are a certain number of operations required to finish the piece. These operations can be lettered including everything from the pattern to the last finishing or other operation.

Before proceeding further, the writer wishes to state that a drawing is a tool just as much as is a jig, templet or other special tool. This is also true of patterns, as a pattern is distinctly a tool, without which those parts made in the foundry could not ordinarily be produced. As explained under drawing symbols, one has a characteristic letter indicating in the first place a drawing which is followed by the piece symbol proper (although of course, as explained above, the entire symbol is used for both piece and drawing). Let it be supposed, for example, that the pattern is the tool for the second operation or piece, and if it is desirable, as it may be in some lines of business to use pattern symbols, the pattern could be known as D1120X1 though it is absolutely superfluous as far as patterns are concerned. It but adds an unnecessary complication and the piece symbol can be used just as well for the pattern as not. If one is referred to piece D1120X he has an identification for the drawing, for the pattern and for the piece—the one symbol applies to all and there is nothing simpler or more satisfactory in practice.

There are subsequent operations after the casting has been made, or the forming is ready for machining, which may require a number of special tools. It is absolutely essential that these tools be easily and accurately identified. Let us assume that there are four machining operations on piece D1120X, for which special tools or jigs have been made, and that these four operations are operations 7, 10, 11 and 16. These jigs or tools would be symbolized respectively, as D1120X7, D1120X10, D1120X11 and D1120X16. Each of the several pieces of which the above mentioned jig or tools are made up should, of course, be stamped with the symbol. If it becomes desirable to identify the separate parts of the jigs, as in cases where a jig is distinctly a double one, e. g. a male and female plug gage, the separate pieces may be identified by the addition of a suffix letter; for example, in a two-part jig, as mentioned above, for piece D1120X (for the eleventh operation), one part of the jig would be numbered D1120X11A and the other D1120X11B.

Operation Symbols

The most desirable symbols for operations, using the operation in the broadest sense, are two-letter symbols, as suggestive as possible. These symbols are necessary for use on work orders and other shop documents to save writing several (and sometimes a dozen) words to express what is desired in the way of instructions. Some of the more common ones are given below. It will be noticed that in almost every instance the symbol is perfectly suggestive of the words it represents. Owing to the limits of the alphabet it is not possible to have any definite rule for constructing a symbol of this kind.

Some symbols taking the place of two words are formed by taking the first letter of each word, as for example AP, which stands for "alter pattern". Another case is a symbol BO for "bore", the symbol in this case

Table I.

OPERATION SYMBOLS

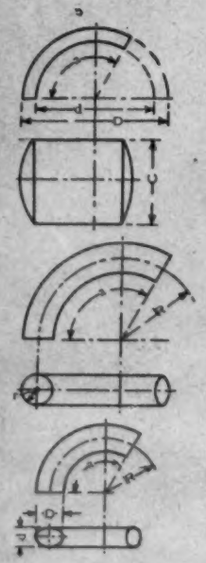
AF —Alter Flask	FI —File	TP —Tap	PP —Prick (or center) Punch
AN —Anneal	FL —Fill	PN —Bend	PR —Pour Out
AP —Alter Pattern	FM —Forming	BO —Bore	PS —Purchase
AS —Assemble	FO —Forge	BP —Bump	PT —Pulling Pot
AV —Approve	FR —Fire	BS —Burnishing	PU —Punch
BA —Balance	FS —Forming Seat	BT —Babbitt	RD —Rub Down
BH —Broach	FT —Fit	BU —Bush	RE —Receive
BK —Bake	FU —Fit Up	BV —Bevel	RI —Riddle
BM —Box Mill	GR —Grind	BX —Box	RM —Ream
CA —Cancel	GS —Grease	BZ —Braze	RN —Requisition
CB —Counterbore	HC —Held up to Check	LB —Laboring	RO —Resume Operation
CC —Set Chills	HD —Harden	LC —List Complete	RP —Replace
CD —Checked	HL —Helping	LD —Load	RR —Repair
CE —Center	HO —Held up by Office	LO —Lay Out	RT —Rivet
CG —Charge	IL —Install	LP —List Partial	RU —Routed
CH —Case Harden	IN —Invoice	LR —Leather	SB —Sand Blast
CK —Chuck	IS —In Stock	MC —Make Cores	SC —Scrape
CL —Clean	IT —Inspect	MD —Mold	SD —Solder
CN —Condemn	JG —Jig	MF —Make Flask	SE —Setting
CO —Cut Off	KE —Key	MI —Miscellaneous	SF —Sift
CP —Chip	KG —Knocking Off Gates	MM —Moved to Machine	SH —Ship
CR —Crate	KL —Kooling (Cooling)	MO —Moved	SK —Shrink
CS —Countersink	KN —Kountin (Counting)	MP —Material Provided	SL —Slot
CT —Cut Teeth	KO —Knockout	MT —Melting	SN —Spin
CU —Core Up	KR —Koloring (Coloring)	MX —Mix	SO —Sort
CZ —Cut Sand	KT —Kutting (Cut or Cutting)	NH —No Help	TR —Trace
DE —Design	SP —Spherical	NP —Nickel Plate	TS —Temper Sand
DF —Defective	SR —Straighten	NY —Notified	TT —Test
DL —Drill	SS —Set Screw	OG —Oil Groove	UD —Unload
DM —Dismantle	ST —Slit	OH —Overhead	UR —Urge
DN —Done	SU —Set Up	OK —O. K.	WA —Waiting for Approval
DO —Dump Out	SV —Shovel	OR —Ordered	WD —Wind
DP —Don't Proceed	SW —Sweep	PA —Paint	WG —Weigh
DR —Delayed for Repairs	TB —Tumble	PB —Plant Break Down	WI —Waiting for Information
DS —Dress	TD —Take Down	PD —Processing Deferred	WI —Weld
DW —Draw	TE —Temper	PE —Prepare Equipment	WM —Waiting for Material
EB —Equipment Broken Down	TF —Tend Furnace	PH —Photograph	WO —Watering
FA —Face	TH —Thread	PK —Pack	WR —Wrapping
FD —Foundry Delay	TM —Trim	PL —Plane	WS —Wash
FH —Finish	TN —Turn	PN —Pattern (make)	WT —Want
	TO —Take Out	PO —Polish	XP —Experiment

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

FORMULAS FOR FINDING THE WEIGHTS OF CASTINGS

By W. L. Tryon.



To find the weight of a sector of a ring made by cutting a cylindrical hole through the center of a sphere, multiply the chord cubed by the number of degrees in the angle by the value of *k* corresponding to the weight per cubic inch of material used. (See table below.)

$$W=C^3ak$$

The chord is equal to the square root of the result obtained by subtracting the square of the diameter of the hole from the square of the diameter of the sphere.

$$C=\sqrt{D^2-d^2}$$

To find the weight of a sector of a ring of circular cross-section, multiply the radius of the cross-section squared by the radius of the circle passing through the center of the cross-section by the number of degrees in the angle by the value of *m*.

$$W=r^2Ram$$

To find the weight of a segment of a ring of elliptical cross-section, multiply the radius of the circle passing through the center of the cross-section by the large diameter of the ellipse by the small diameter by the number of degrees in the angle by the value of *k*. (See following Data Sheet.)

$$W=RDdaK$$

ALL DIMENSIONS IN INCHES AND WEIGHTS IN POUNDS

Wt. per cu. in.	k	m	Wt. per cu. in.	k	m	Wt. per cu. in.	k	m	Wt. per cu. in.	k	m
.096	.000140	.00526	.210	.000305	.01151	.330	.000480	.01809	.450	.000654	.02467
.100	.000145	.00548	.220	.000319	.01206	.340	.000495	.01864	.460	.000669	.02522
.110	.000160	.00603	.230	.000334	.01261	.350	.000509	.01919	.470	.000684	.02577
.120	.000174	.00658	.240	.000349	.01316	.360	.000524	.01974	.480	.000698	.02632
.130	.000189	.00713	.250	.000363	.01371	.370	.000538	.02029	.490	.000712	.02687
.140	.000203	.00768	.260	.000378	.01426	.380	.000553	.02084	.500	.000727	.02742
.150	.000218	.00822	.270	.000393	.01480	.390	.000567	.02138	.510	.000741	.02796
.160	.000233	.00877	.280	.000407	.01535	.400	.000582	.02193	.520	.000756	.02851
.170	.000247	.00932	.290	.000421	.01590	.410	.000596	.02248	.530	.000770	.02906
.180	.000261	.00987	.300	.000436	.01645	.420	.000611	.02303	.540	.000785	.02961
.190	.000276	.01042	.310	.000450	.01700	.430	.000625	.02358	.550	.000800	.03016
.200	.000291	.01097	.320	.000465	.01755	.440	.000640	.02413	.560	.000815	.03071

INTERPOLATION TABLE

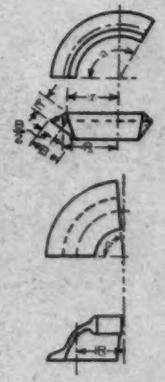
Add'l. Wt.	Add'l. k	Add'l. m	Add'l. Wt.	Add'l. k	Add'l. m	Add'l. Wt.	Add'l. k	Add'l. m
.001	.000001	.00005	.004	.000006	.00022	.007	.000010	.00038
.002	.000003	.00011	.005	.000007	.00027	.008	.000012	.00044
.003	.000004	.00016	.006	.000009	.00033	.009	.000013	.00049

For method of Interpolation see Data Sheet No. 129.

DATA SHEET NO. 175, THE FOUNDRY, DEC., 1914.

FORMULAS FOR FINDING THE WEIGHTS OF CASTINGS

By W. L. Tryon.



To find the weight of a segment of a ring of triangular cross-section multiply the base of the triangle by the altitude by the sum of twice the radius of the circle described by the center of the base and the radius of the circle described by the vertex of the triangle by the number of degrees in the angle by the value of *M* corresponding to the weight per cubic inch of material used.

$$W=BTaM(2R+r)$$

To find the weight of a segment of a solid generated by revolving a plane area about an axis, multiply the area by the distance from the center of gravity of cross-section to the axis by the number of degrees in the angle by the value of *N*.

$$W=ARaN$$

For finding area of irregular figures, see Data Sheet No. 111. For finding center of gravity, see Data Sheet No. 112.

ALL DIMENSIONS IN INCHES AND WEIGHTS IN POUNDS

Wt. per cu. in.	K	M	N	Wt per cu. in.	K	M	N	Wt per cu. in.	K	M	N
.096	.00132	.000279	.00168	.250	.00343	.000727	.00436	.410	.00561	.001193	.00715
.100	.00137	.000291	.00175	.260	.00356	.000756	.00454	.420	.00575	.001222	.00733
.110	.00150	.000319	.00192	.270	.00370	.000785	.00471	.430	.00589	.001251	.00750
.120	.00164	.000349	.00210	.280	.00384	.000815	.00489	.440	.00603	.001280	.00768
.130	.00178	.000378	.00227	.290	.00397	.000844	.00506	.450	.00617	.001309	.00785
.140	.00192	.000407	.00244	.300	.00411	.000873	.00524	.460	.00630	.001338	.00803
.150	.00206	.000436	.00262	.310	.00425	.000902	.00541	.470	.00644	.001368	.00820
.160	.00220	.000465	.00279	.320	.00438	.000931	.00558	.480	.00658	.001397	.00838
.170	.00233	.000495	.00297	.330	.00452	.000960	.00576	.490	.00672	.001426	.00855
.180	.00246	.000524	.00314	.340	.00466	.000989	.00593	.500	.00685	.001455	.00873
.190	.00260	.000553	.00331	.350	.00480	.001018	.00611	.510	.00699	.001484	.00890
.200	.00274	.000582	.00349	.360	.00493	.001047	.00628	.520	.00713	.001513	.00908
.210	.00288	.000611	.00366	.370	.00507	.001076	.00645	.530	.00727	.001542	.00925
.220	.00301	.000640	.00384	.380	.00521	.001106	.00663	.540	.00740	.001571	.00942
.230	.00315	.000669	.00401	.390	.00534	.001135	.00680	.550	.00754	.001600	.00959
.240	.00329	.000698	.00419	.400	.00548	.001164	.00698	.560	.00768	.001629	.00977

INTERPOLATION TABLE

Add'l. Wt.	Add'l. K	Add'l. M	Add'l. N	Add'l. Wt.	Add'l. K	Add'l. M	Add'l. N	Add'l. Wt.	Add'l. K	Add'l. M	Add'l. N
.001	.00001	.000003	.00002	.004	.00005	.000012	.00007	.007	.00009	.000020	.00012
.002	.00003	.000006	.00003	.005	.00007	.000015	.00009	.008	.00011	.000023	.00014
.003	.00004	.000009	.00005	.006	.00008	.000017	.00010	.009	.00012	.000026	.00016

For method of Interpolation, see Data Sheet No. 129.

DATA SHEET NO. 176, THE FOUNDRY, DEC., 1914.

being the first two letters of the word and suggestive. Again, the symbol BX for "box" consisting of the first and last letter of the word, is suggestive. In some cases the symbol is phonetic, as in the case of XP for "experiment". An hour's study of this list will enable one to memorize practically every symbol represented. Of course, different lines of business require different operations, but the list given can be used as a guide, and modified or expanded to suit individual cases. The operation symbols are given in Table I.

Drawing Symbols

In connection with special detail drawings with but one piece depicted on a sheet, the following scheme of drawing numbers, or symbols has been evolved. In ordinary shop practice, shop drawings generally show several or more pieces on one sheet which are issued to the shops either in the form of pencil drawings or blue prints. This method, however, is obsolete and modern practice is gradually coming to the new method of making individual drawings, showing but one piece on a sheet. The advantages of this are many, but need not be taken up here. In each case every piece must be drawn and figured complete, with clearances and tolerances, so it makes little difference in the work required whether several pieces are made on one sheet or on several individual sheets.

Bearing in mind the fact that one piece is shown on a sheet, and this piece properly symbolized, the following method has been devised for drawing symbols. The primary object is to obviate a double index, and to use the piece symbol for the drawing symbol with a characteristic letter to indicate the size of the drawing. It is necessary, of course, to use standard-size sheets, which for convenience may be lettered as follows:

A size, 6 x 9 inches.
B size, 9 x 12 inches.
C size, 12 x 18 inches.
D size, 18 x 24 inches.
E size, 24 x 26 inches.

Obviously it would not be practical to file these various sizes of drawings in one or more drawers, and thus mixing the different sizes of sheets. Assume now that we have detail drawing, showing the required number of views of one piece which we know by its symbol as piece 1120X. If the piece is drawn on a D size sheet (18 x 24 inches) the sheet or drawing symbol would be D1120X.

Bear in mind now that the X in the symbol indicates a piece symbol, and that all piece-symbol numbers are followed by one or more letters, the first of which is always an X. When a drawing reference reads D1120X, it means the drawing for piece 1120X. On the other hand, knowing the piece symbol 1120X would not enable us to locate at once the drawing; the combination should, therefore, always be used.

Primarily all that is needed for the piece symbol is the 1120X (and for special alterations or changes the suffixes consisting of a numeral or letter as previously explained). To combine the piece symbol and the drawing symbol, however, it becomes necessary to differentiate between the different sizes of sheets used in the drawing room. Hence use the prefix, or characteristic letter. Were it practical to make all detail drawings on the same size of sheet, the first letter would be unnecessary.

Table II.
EXAMPLES OF THE USE OF SYMBOLS

1A to 1Z	Departments
X1, X2, X3, etc.	are expense symbols indicating subdivision departmental expenses
O26050a	General order number
C1160	Contract number
L1520	Stock job number
M3160	Miscellaneous job number
P590	Plant job number
F329	Factory job number
1UM11	Milling machine, number 11, located in machine shop (1U)
DZ164	A miscellaneous tool not a commercial article
1UX6B11	An expense charge (6) to boring machine 11 (B11) located in machine shop (1U)
E5201X	Piece Symbol
E5201X13A	Special tool or jig for piece E5201X
E5201X1	Special part made by altering pattern of E5201 X
E5201XA	A special piece made by machining a standard casting E5201X special
BO	Operation symbol for bore
E1120	A drawing on a sheet 24 x 36 inches. Detail drawings of an individual piece, no matter what it may be, are symbolized the same as the piece symbol.
LF26	Letters in vertical filing folder 26
D3C40	Date filed on a 3 x 5 card No. 40
L401A	Manufacturing number of a stock part made on job L401

Filing Symbols

Drawing filing cases must of course be provided with drawers or compartments of the proper sizes to take each of the above mentioned sizes of sheets, namely, A, B, C, D, E, etc. By this arrangement all A size sheets (6 x 9 inches) will be together or in adjacent compartments, and arranged numerically in order of the number following the characteristic letter. This same arrangement is carried on throughout for each size of drawing.

A comprehensive scheme of filing requires a rather complete system of symbols. In the development of a filing system the characteristic letters of the symbol must suit the specific conditions for which it is devised.

The complete general index of 3 x 5-inch cards should include all data necessary to locate any matter whatsoever of which there is any record. This index will in most cases be on the double or triple cross index system, and in many cases matter will be indexed under as many suggestive "catch names" as possible to insure its easy location. Generally speaking, the alphabetical index will locate the record at once without cross reference.

The Use of Manufacturing Numbers

For purposes of identification of various pieces manufactured, especially the large and important parts of a machine, each part will be given a manufacturing number, or symbol. This number will consist of the stock job or merchandise job number followed by a letter, as L-401A, or L-401G, or again M-2809V, etc. The final letter of the symbol will be different on each piece built on a certain job, but the job number is the same. It is apparent by inspection that parts with a manufacturing number L401A, L401B, etc., were built on the same stock job, viz., L401.

If a stock job L401 calls for 12 pieces, then the manufacturing numbers run from L401A to L401L, inclusive. The same method, of course, applies to any manufacturing done on merchandise job numbers, but this will be an exception, as it is desirable to manufacture only on stock jobs, which numbers are always preceded by the letter S, and are the only job numbers used for the manufacturing of one or more single pieces exactly alike.

The manufacturing numbers on frames will in all cases be stamped on the main casting at some predetermined space, instead of marking the piece promiscuously. Care must be taken when filing and rubbing down not to cover the manufacturing number. The space bearing the manufacturing number should be indicated by having a white circle painted around it for easy identification. It is desirable, however, that the final

coat of paint with a little machine filler should thoroughly cover the number previous to shipping, so that there will be no possibility of the customer finding it and mistaking it for the shop number.

Other articles will be numbered likewise as the necessity presents itself, and in all cases, excepting on frames or columns, which bear the shop number, the manufacturing number must be plain and in a conspicuous place. The manufacturing number should be noted on the article as soon as it arrives at the works, or if in stock, as soon as it is withdrawn from stock and before any work is done.

Resume

It must be understood that the arrangement of numbers and letters as described throughout this article can be modified or changed to suit conditions. A different arrangement of these characters does not change the principle involved. The examples given are simply in way of illustration, but they follow very closely a system of symbols which has proved successful in practice.

Though to the layman a symbol scheme seems complex, it works out in practice very simply as taken up step by step. It has proved a great labor-saving device, especially in connection with modern methods of management. Though in effect arbitrary, they can be generally applied and are not limited to any special kind of business. Table II shows the application of symbols.

(To be continued.)

New Design of Cupola

(Continued from page 469.)

proper intervals for the lining and an angle is placed around the top.

Two charging doors are provided and when desired these doors are of the lifting type, operating in vertical guides, counterweighted and fitted with an apron attached to the shell to serve in connection with a charging machine. Special doors may be installed for any method of power charging.

The lining recommended consists of blocks 6 x 9 inches wide and 6 inches thick, forming an inner lining, backed by regular square and arch firebrick set edgewise against the shell.

The tuyeres are of such form that it is not necessary for the bricks to fit around individual tuyeres and the lining is easily laid at this usually difficult point. This saves at least a day's time in relining the cupola. Among the principal advantages of this new construction is the arrangement of the damper in each blast box, which enables the attendant to readily control lighting up and burning through the bed, which must be burnt through evenly before last of the coke is put on and charging is commenced to obtain the best results. Or, in case the cupola is melting badly and great oxidation is taking place at one point, which can be noted at the charging door, the individual blast gate gives the operator a means of overcoming the improper working condition. Also, by proper regulation of the dampers, unequal cutting of the lining is prevented.

Another superiority is due to the arrangement of continuous annular tuyeres in combination with liberal size peepholes which permit inspection of practically the whole interior of the cupola and of reaching every part with a poke bar if necessary. The inwardly extending flange on the tuyere cover causes the molten metal and stock to descend clear of the tuyere opening and insures full admission of the blast. The area of the tuyere opening at the inside of the lining is very liberal.

Design of Base

The design of the base with the square bottom plate and columns located at the corners gives clearance for the bottom doors and for the cupola tender in cleaning out the drop and daubing up. With a steel base plate there is less danger of cracking as in the cast iron construction when water is thrown carelessly on the cupola after dropping the bottom.

The bottom doors have perforated cast plates with deep ribs and heavy hinge lugs, designed specially to equalize shrinkage and withstand heating and cooling. The doors are provided with pads for props and are arranged for the attachment of bottom door hoists. The lugs for the bottom door pins are structural steel and are bolted to the steel bottom plate.

An important feature in large cupolas is the provision for an operator's and tapper's platform of convenient height and substantial construction. This design of base readily lends itself to this construction. While I admit some features of this design are old, it is claimed that the combination is new and affords facilities seldom brought together for convenience, safety and efficiency in cupola operation. The cupola was designed by the Whiting Foundry Equipment Co., Harvey, Ill.

The 1915 Foundrymen's Meeting and Exhibit

The joint convention committee representing the American Foundrymen's Association, the American Institute of Metals and the Foundry & Machine Exhibition Co. has decided to hold the next annual meeting of these allied organizations at Atlantic City during the week of Sept. 27, next year. The exhibition of foundry equipment, supplies and machine tools will be held on the steel pier where the meetings of the American Foundrymen's Association and the American Institute of Metals also will be held. The pier provides ample exhibition space and the selection of this well known resort meets with the hearty approval of the members of the various organizations. A movement is now on foot which probably will result in the affiliation of the Associated Foundry Foremen with the American Foundrymen's Association and it is believed that this will be consummated about the first of the year.

Cost and Efficiency System

The Esseness Co., lock box 42, Holyoke, Mass., specializes in the installing of manufacturing cost and efficiency systems. The Noyes system of factory cost which it installs is founded on the plan of a clearing house arrangement by departments and general factory distribution of overhead charges. Each department is treated as though it were dependent entirely upon its own resources, sharing in the general expense by proper ratios, etc. It is claimed that the system does not interfere with the general accounting system of a corporation, but is planned in such a way that it can enter the general ledger without change in the latter.

"Steel Castings" is the title of a house organ published by the Tropenas Converter Co., New York City, the first issue having appeared under the October date. The leading article by G. Muntz, of that company is entitled "Tropenas Converters versus Electric Furnaces for the Manufacture of Steel Castings." The purpose of "Steel Castings" is to disseminate information concerning the manufacture of the product from which it derives its name.

The Moser Pattern Works, Newark, O., has been compelled to move into larger quarters owing to the increase in its business and the plant formerly occupied by the Electric Light Co., of Newark has been leased and fully equipped with a full line of wood and metal patternmaking machinery. In addition, a brass and aluminum furnace has been installed.

Developments in Electric Brass Furnace Melting

Description of New Type of Furnace for Non-Ferrous Metals Designed to Utilize the Pinch Effect

By G H Clamer and Carl Hering

THE purpose of this paper is to describe some recent researches and developments in the field of commercial brass melting with a special type of furnace.

In the particular type of furnace used in these researches the heat is set free as such in a small portion of the liquid metal in some heating holes at the bottom of the hearth, and then by means of a pressure produced by a recently discovered and peculiar electromagnetic force known as the "pinch effect", this heated metal is "squirted" with a considerable force into the main bath, whereby its heat is carried very quickly as hot metal into the bath and is there distributed and whereby the metal is at the same time very thoroughly stirred, making it uniform. The cold metal is melted by immersion in this hot bath, like in all covered crucible melting. Cold metal when immersed in superheated liquid metal and wetted by it, takes up heat very rapidly, and anything that increases the speed of melting lowers the standby losses; hence poking the cold metal down into the hot bath is an advantage. This "pinch pressure" operates like a valveless pump, forcibly expelling the freshly heated metal from the heating holes or channels, called resistors, and sucking in the cooler liquid metal from the bath.

This peculiar and heretofore unknown electromagnetic force, which is of considerable magnitude, was noticed by one of the authors some years ago, in a resistance steel furnace with open channels, and proved to be fatal to that furnace, as it kept breaking or pinching off the column of liquid, by crushing it; it is the first mechanical force internal to a conductor, known to the electric art, all the other forces being external. In the present type this force was then applied to circumferentially closed channels of liquid metal submerged beneath the bath, so that rupture could no longer take place; the force tending to crush the conducting column of liquid metal was thereby made to "squirt" it out of the heating holes, whereby the absolutely essential rapid circulation in these heaters is produced. This type of furnace is sometimes referred to as the "pinch effect furnace", as this peculiar force is the underlying and essential feature of it. Such a furnace heats the liquid metal from the bottom which is the correct way to heat any liquid, and of course the most rapid way.

Due to this rapid heating the losses of heat are reduced because the time during which the metal is kept hot, is shortened. If a ton of metal per hour is melted and poured in 500-pound lots every 15 minutes in a small furnace, the continuous standby losses through the walls and the top will be only those from 500

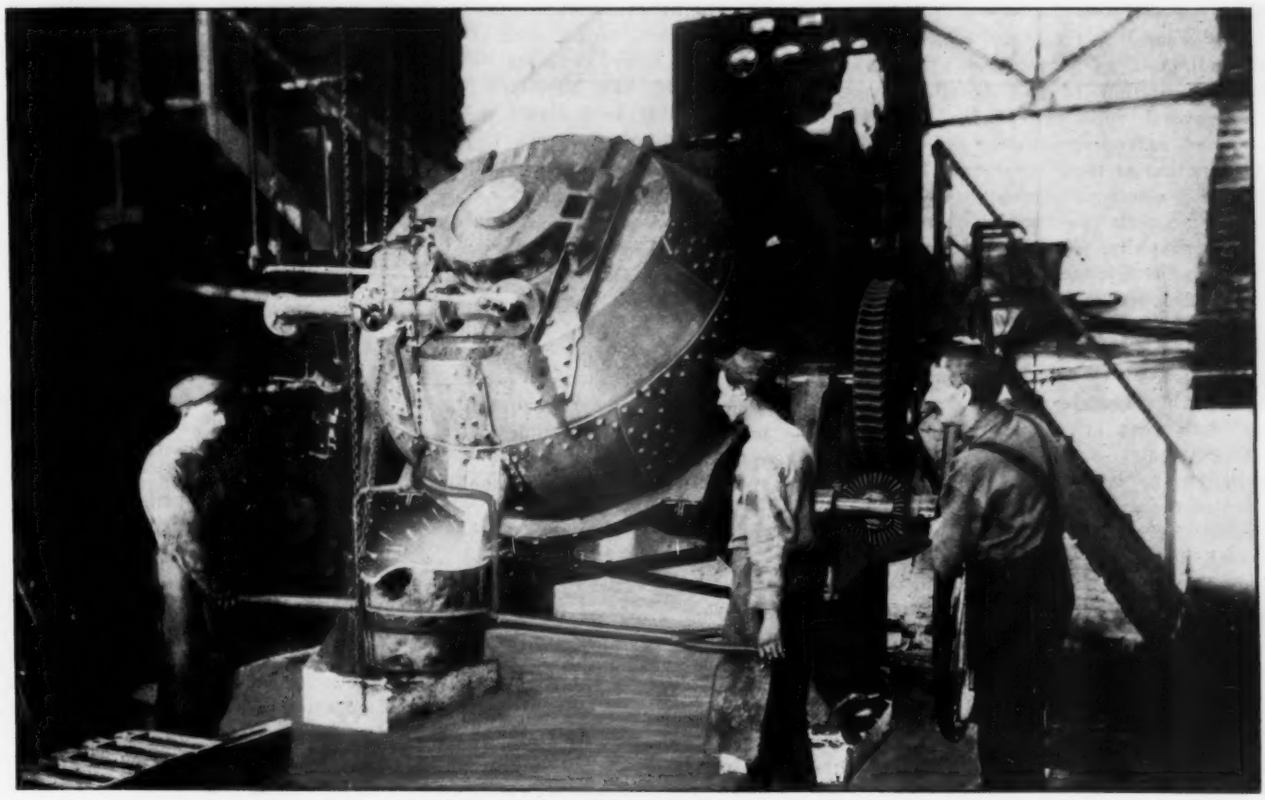


FIG. 1—POURING BRASS FROM A HERING ELECTRIC FURNACE

From a paper read at the annual meeting of the American Institute of Metals, Chicago Sept. 7-11, 1914.

pounds, while if melted and poured in ton lots every hour these losses will be several times as great.

Pour Directly in the Molds

The ideal method, therefore, is to melt and pour as quickly as possible, hence in as small lots as the particular conditions of the foundry require, though this, of course, need not be carried to extremes. It is thought, however, that for small castings at least, a high power tilting brass furnace of this type could be constructed small enough to be transported to the molds, pouring directly into them, thereby saving the process of pouring with a ladle with its labor cost, and the cost of the superheat necessarily involved in indirect pouring.

In general this furnace consists of a shell lined so as to form a hearth. At the bottom of this hearth there are several cylindrical holes, usually inclined, extending into the lining and terminating at their outer ends by the metallic electrodes, usually made of the same metal as that to be melted, or of graphite. The electric current led into the furnace by means of these electrodes, passes through the columns of liquid metal in these holes and it is here that the electric energy is converted into heat and from which the freshly heated metal is squirted out into that in the hearth. These heating holes are technically called resistors, as it is the electric resistance of the metal in these holes which causes the electric energy to be converted into heat. The electrodes lead out to the outside of the furnace where they are attached to transformers in which the kind of current required by this furnace is generated. These transformers are preferably secured mechanically to the shell, hence the heating can continue while the furnace is tilting for pouring.

In starting from the cold state this furnace must first be primed with a small charge of liquid metal, enough to fill the holes and the bottom of the hearth, so that the circuit for the current is established. A few fragments of zinc, tin or aluminum inserted in the bottoms of the holes insure the union of the liquid priming metal with the electrodes at the first start from the cold. During regular pouring enough liquid is retained to maintain this electric circuit.

On shutting down the furnace it is tilted or drained so far that the heating holes are also emptied of their metal except for a short stump at the bottom. In some cases the charges in the furnace were allowed to freeze and it was afterwards started up again by melting the solid charge with the current; but at present this is not recommended as a general rule except when the metal in the furnace is not hot short as hot short metal is apt to break the electric circuit by cracking in the resistors when the furnace cools or is heated up. A blast fuel flame is desirable for starting up a furnace with a frozen charge.

An electric furnace has its best efficiency when run continuously day and night; this is also better for the lining, which may become strained by repeated heating and cooling. The cost of electric energy is also generally less per kilowatt hour for continuous than for intermittent supply. When this continuous running is not practical, this furnace may be kept hot over night with about 20 per cent or even less, of its normal input. A large body of metal in a well heated and well insulated furnace will probably keep liquid in the bottom for a number of hours, perhaps all night, without any current.

Superheat Obtainable

Any degree of superheat can of course be obtained, depending only on the money one is willing to spend for this superheat. One need merely keep the melted metal in the furnace with the full current on. Owing to the higher cost of electric heat, it is of course desirable to require as little superheating as possible. The ideal method would be to cast directly from the furnace into the molds, by bringing the molds to the furnace, say on a sort of suspended carrousel or by floating them on a canal.

The wearing away of the walls of the heating holes was at first expected to be an important matter, but to our surprise this wear seems to be either negligible or entirely absent even in steel furnaces in which the temperatures are much higher; in these latter they become coated with a black layer which seems to replace itself as fast as it wears away. In brass furnaces, when care is taken not to let any slag get into the holes on emptying the furnace completely before a shut-down, the walls of these holes remain clean and smooth and are entirely unattached.

The cost of relining, which takes the place of the cost of the crucible in fuel furnaces, will not be great, being no doubt considerably less than the cost of the crucibles. We have no figures yet, but in the improved type with the heating holes coming in from the side instead of from the bottom, we know that the relining is a simple matter.

The flow of metal in the heating holes is downward at their circumference and upward in the center, hence is in both directions; the outward velocity is by far the greater; there is really a suction at the surface of the holes, hence an absence of erosive action, the flow is steady and not intermittent. We estimate that each particle of metal is in the holes on an average roughly about a second and is heated about 50 degrees Cent. higher than when it entered, but these figures are naturally only very rough estimates and vary greatly with the design and the metal.

It is quite surprising, however, what a large amount of heat can be carried out of these holes effectively by the rapidly flowing metal; it exceeds that of a row of electric arcs in those holes. At present about 25 to 50 kilowatts are converted into heat in each hole, or roughly about 90,000 to 200,000 British thermal units per hour, with the probabilities that this can be considerably increased. The correct proportioning of these holes and the current are of great importance. These proportions are quite different for brass than for steel. The furnace must be especially designed for each metal, though variations in the compositions of brasses and bronzes can however be taken care of in the same furnace by regulation of the electric current.

Even copper with its very low resistance can be melted commercially in these furnaces without requiring impractical proportions. The higher the electrical resistivity of a metal the better the proportions become.

The rapid flowing of the metal in the heating holes, which is the basis of this type of furnace, is a phenomenon based on the use of a large current, hence these furnaces must be operated with low voltages and great amperage. For this reason the currents are best converted by transformers attached directly to the furnace, as long leads for such large currents would be expensive and troublesome.

Use of Low Currents

Our researches have shown, however, that the currents may be much smaller than was at first supposed. Our brass furnace is running with about half the current originally intended and double the voltage. This is due to the development of an unexpectedly high counter electromotive force, which is a very favorable feature, as it improves the proportions of the furnaces, by enabling lower currents to be used. The energy represented by this counter electromotive force is also converted into useful heat.

Under normal conditions the cur-

rent is perfectly steady, hence these furnaces become a very desirable "load" for central stations, and may for this reason be granted lower rates, especially as the current need not be cut off during pouring, and because the furnace could easily be cut out of circuit (except for a small current to keep it hot) during the time of the so-called "peak" loads, during which the charges for current are necessarily and justly somewhat higher.

Should the ammeter needles start to oscillate it means that the columns of liquid metal in the holes are parting either because the level of the liquid metal above the holes is too low, or in the case of zinc alloys, that the temperature is unnecessarily high, causing some zinc to volatilize and form bubbles in the heating holes. In either case the addition of some cold metal will at once stop it. The operator soon learns how to avoid both.

Any of the usual alternating currents used for lighting or power can be adapted to this furnace, as they are always transformed at the furnace to the required voltage and current. Single phase, two - phase or three - phase currents can be used without any complications, there being then two, four or three heating holes; three-phase current is probably the best and is the kind most generally available. Any frequency may be used, although, of course, the lower the frequency the better. If the supply mains have a dangerously high voltage, it is preferable, on account of the safety and comfort of the operators to first transform the current, in protected places, down to the safe voltage of the usual lighting and power circuits.

The power factor of this furnace, even with 60 cycles, is not low, as has been supposed, but was found to be in the eighties and nineties, and even this small reduction from 100 per cent was no doubt largely, if not all, in the transformers and could be avoided in a better design of the transformers. In a steel furnace with a frequency of 25, the power factor was practically 100 per cent, hence perfect. This factor has nothing to do with the efficiency but merely means larger electrical parts when it is considerably below 100 per cent.

Convenient means for regulating the furnace current without wasting power, are provided at or near the furnace. But, like most other machines, this furnace runs best at the normal current for which it is designed, and the greatest economy is obtained by running steadily night and day, which also diminishes the size of number of furnaces for a given annual output.

The furnaces may be designed with a replaceable shell, so that a spare shell may be kept ready to be substituted, thereby avoiding the loss of time in relining and drying. But as this relining and drying could, in most cases, be done during a Sunday stoppage, no great importance is attached to such spare shells, except in the case of repairs.

As the top and all but one side are free from all electric appliances, the slag or skimming doors, spout, feeding hopper, roof, etc., may be located and constructed as the owner prefers. The furnace may readily be made to tilt around the spout or lip as a center, thereby facilitating casting directly into molds, which, of course, saves considerable expensive superheating and labor.

No accurate tests have yet been made for determining the electric power required per 100 pounds of various copper alloys, partly because this can be determined fairly only during long, continuous runs on the same material and with clean charging scrap, as a large part of the charge is preferably retained in the furnace for facilitating the melting of the next charge. Another reason for not measuring it was because the furnace has so far been used for melting very light brass and bronze chips, which gave trouble in the fuel furnaces. Moreover, in such a test, the temperature should be carefully measured because the power required depends quite considerably on the amount of superheat desired, and this is different with different foundrymen, depending largely on their skill or lack of skill in casting quickly.

In melting many tons of these light, curly and oily brass chips with much mechanically mixed iron, we cast in the form of clean ingots, nearly 8 pounds per kilowatt-hour, delivered to the furnace transformers, equal to about 12.5 kilowatt hours per 100 pounds poured; a considerable portion of this energy went into the dross and was lost through the open hopper, through which the cold charge had to be "poked." Moreover, the transformers were not working properly and were wasting much heat, and in this particular furnace there were four electrodes (for a two-phase current), instead of only three (for a

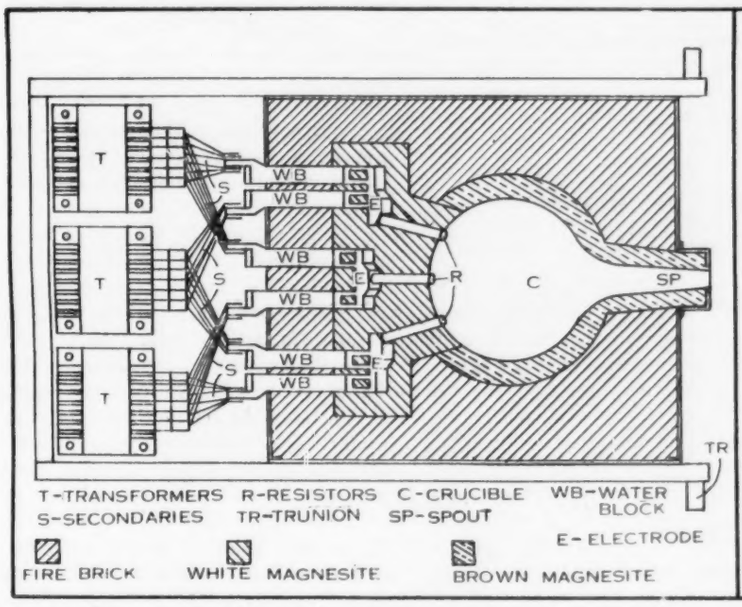


FIG. 2—SECTIONAL PLAN OF ELECTRIC BRASS FURNACE

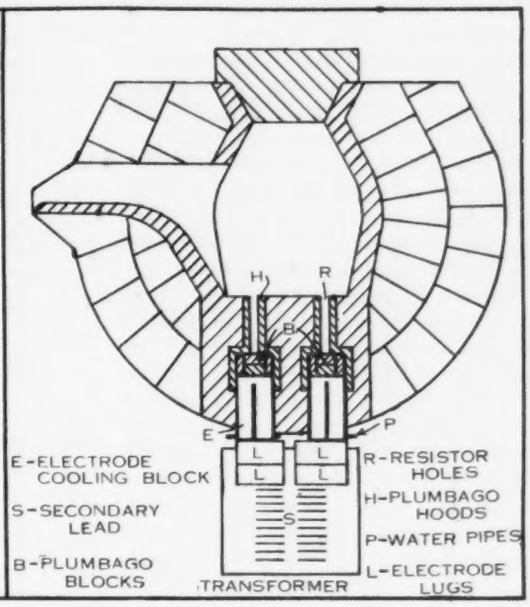


FIG. 3—CROSS-SECTION OF FURNACE

three-phase current), which latter would be more general, hence the electrode losses were greater than they would be normally; and the electrodes had been proportioned for a much larger current, hence were unnecessarily wasteful in heat loss.

Short runs, with clean ingot charges, indicated that, even with these easily avoidable excesses in the losses, 10 pounds per kilowatt-hour could be obtained in this furnace, hence, in better designs, even still better efficiencies than this can reasonably be expected. But, as said above, this figure depends largely on the amount of superheat required by the particular foundryman.

It is not fair to any furnace to calculate the actual efficiency in per cent by comparing this figure with the theoretical one, because the latter is not known definitely and may be far in error. Also, because the superheat required by some foundrymen is far greater than that in the assumed theoretical value. What actually is of prime interest to the user is the cost in cents per 100 pounds of good, saleable castings, and this is not dependent on any doubtful theoretical values.

The economy of the electric melting could be greatly increased by preheating the charge with a fuel flame, preferably in an auxiliary furnace, to only such a temperature at which no oxidation takes place. Nearly half the melting heat could thus be introduced into the metal whereby the economy of the electric heating could be nearly doubled. Such low temperature heat is more cheaply produced by fuel, while the high temperature heat is introduced into the metal more cheaply electrically, hence this combination of both gives the best total economy.

Comparative Costs

Comparative costs with fuel furnaces can be only crude because the data concerning them differ so very greatly in different foundries. But taking what appear to be fair general averages largely from the recent Bulletin 73 of the Bureau of Mines compiled by Dr. H. W. Gillett, the following rough comparisons can be made:

He concludes that the average loss of metal in fuel furnaces is about 2.5 per cent per melt; it is probably greater in most foundries, and as this is the largest item of expense with fuel furnaces, it is hardly fair to the electric furnace to take it so low; but we will assume this low figure and allow 0.5 per cent for the electric furnace. Limiting this comparison to only the fuel or current, the crucibles and the loss of metal, gives the following per 100 pounds, assuming $4 per gross ton for the coke, and the average value of the metal as 10 cents per pound, based on the present low metal value; ordinarily it averages about 50 per cent higher:

	Cents.
Pit, natural draft, coke, furnace:	
Coke, 45 pounds	8.0
Metal loss, 2.5 pounds	25.0
Crucibles	7.0
Total	40.0
Pit, forced draft, coke, furnaces:	
Coke, 35 pounds	6.3
Metal loss, 2.5 pounds	25.0
Crucibles	7.0
Total	38.3
Tilting, forced draft, coke, furnaces:	
Coke, 20 pounds	3.6
Metal loss, 2.5 pounds	25.0
Crucibles	6.0
Total	34.6
Open-flame, tilting, oil furnaces:	
Oil 3 gal. at 4 cents	12.0
Metal loss 3 pounds	30.0
Relining	1.2
Total (to which should be added the cost of the compressed air blast)	43.2
Electric furnace:	
Power at 1 cent per kwh. and 10 lbs. per kwh.	10.0
Metal loss ½ pound	5.0
Relining	1.2
Total	16.2
Power at 1.5 cents per kwh. and 8 lbs. per kwh.	18.8
Metal loss ½ pound	5.0
Relining	1.2
Total	25.0

The labor cost for charging, pouring and attending to the operation of the furnace may be the same, but the cost of starting the fires and for the handling of the coal and ashes, are absent in the oil and electric furnaces and should therefore be added to costs for the coke furnaces. In the wrought brass industry there is a saving of labor with the electric furnace due to larger ingots, which would no doubt be a much greater item than the difference in cost of melting.

Melting was done at night only, on account of lack of spare power in the works during the day. The furnace was kept hot and at an even temperature during the day with a little less than 20 per cent of the full power. This figure will become still smaller when certain easily preventable losses have been avoided. The hearth held about 1,500 pounds and about half of this was retained to facilitate melting the next charge. The shape of the hearth was not good as it induced bridging of the cold charge; this and other details are readily changed in new designs.

From the foundryman's standpoint the melting was quite satisfactory, and the ease of manipulation and preventing loss of metal, leaves little to be desired. When closed there was no sensible radiant heat from the outside. Our workmen were found to be drying their shirts by laying them on the top of the furnace while the metal therein was at pouring temperatures.

Difficulties Overcome

The development of this type of furnace involved many difficulties largely because it was an entirely new and somewhat radical departure from existing practice, hence no precedents existed. All the data for constructing it had to be found out experimentally, and each trial furnace had to be run to destruction to bring out its weak points. Our scrap heap contained probably about fifty furnaces. Furnaces of this type must moreover be carefully calculated and designed in their electrical parts or they will not operate satisfactorily.

Manganese Flour as Surface Hardener

A new use for metallic manganese has recently been introduced by the Goldschmidt Thermit Co., 90 West street, New York. The metal in the form of a powder, known as manganese flour and containing 98.5 per cent manganese and free from carbon, is now being extensively used for facing steel castings which in service require a soft steel center and a very hard surface. The majority of these castings are used in rolling mills, flour mills, cement mills and in situations where grinding and crushing machinery, dredging and ore lifting buckets are employed. The castings are principally wabblers, gears, pinions, bucket bottoms and spindle pods all subject to severe service.

Manganese flour is mixed with linseed oil to the consistency of a wash and then applied to the mold to a depth of 1/16 to ⅛ inch. Silica wash is applied as usual before the manganese. The mold is then baked and the steel poured, the manganese being absorbed on the surface. On cooling, the surface of the casting is said to be so hard that it cannot be machined. Several large steel companies are using this process on gears and pinions in particular. Reports are to the effect that such gears wear from 4 to 5 times longer than formerly. The process in principle is quite old, but ferro-manganese was used in former attempts which is said to have caused the trouble, the 6 to 8 per cent of contained carbon making the surface of the castings rough and blowy.

The foundry of the Samuel J. Creswell Iron Works, Twenty-third and Cherry streets, Philadelphia, was damaged by fire recently, entailing a loss estimated at $40,000.

The Philosophy and Properties of Alloys

A Discussion of the General and Specific Properties of Non-Ferrous Metals and Their Behavior in Combination

By R R Clarke

A WAY back somewhere, beyond the dimness of history, it was written that it is not good for man to be alone. We sometimes think it must have been written elsewhere that it is not good for metals to be alone. At any rate, some of them are of little value in their single state, so we make unions among them. But we do not call these unions matrimony, bigamy, nor alimony; just simply an alloy.

An alloy is a contention between metallic qualities, an arbitration of metallic differences. The introduction of one metal into another presupposes these differences and anticipates an arbitrated product. Briefly speaking, an alloy is the union of two or more metals objective to qualitative change.

In the completed content of the alloy, three types of union are possible: The chemical, the chemical-superinduced, and the mechanical. A chemical union is one in which the constituents part with their identity in the mix and combine to form a different atomic product. In short, a chemical union is an atomic union and arises from the perfect affinity between the combining elements. Examples of a chemical union are: Tin, 10 and lead, 10; copper, 85 and tin, 15; copper, 85; tin, 6; lead, 5 and zinc, 4. In the last named alloy no individual particle of any one of its constituent elements will exist, but rather a copper-tin-lead-zinc molecule.

Chemical-Superinduced Union

A chemical-superinduced union is one in which two or more metals of affinitive variance are persuaded to chemically combine through the influence of an additional element. This additional element, in the majority of instances, will be found to possess a strong affinity in common to the metals at variance and act as an arbitrator to their mixing differences. An example of such a union is copper, 80; tin, 10 and lead, 10. Above 4 per cent of a lead content, copper and lead will not mix. Tin alloys perfectly with both and through its influence a chemical union in the alloy is realized.

A mechanical union is one in which two or more metals not affinitively inclined and retaining their identity in the mass are uniformly distributed in quantitative ratio therein. This distribution is accomplished through mechanical means or manipulation, such as stirring, rapid reduction from liquid to solid state, successive inversion of receptacle, etc. It also can be realized in part through superinduction, said superinduction consisting in introducing elements creative of a network within the meshes of which the metals are caught and held together. An example of a mechanical union is: Copper, 77; lead, 18; tin, 4 and nickel, 1.

These definitions of the different types of union owe their feature-control to a consideration of the elements in particular and their tendencies in single and combining state. Getting away from the parts and proceeding to a study of the whole we derive evidence and particulars on which to build a different descriptive statement in each individual case.

Individual Qualities

Assuming that nothing is known of the alloy's constituency, with the mass chiefly considered, we can resort to the individual qualities of each type and describe them with reference to their composite features. When thus considered, a chemical union is one in which the alloy can, under no conditions, be resolved into its elements by physical change, whose constituents cannot be isolated by any physical or mechanical process; a chemical superinduced, one in which the isolation of constituents is prohibited by chemical affinity, partially native and partially supplied; a mechanical, one in which the alloy will readily resolve into its elements in consequence of physical change from solid to liquid state. Thus copper, 90 and tin, 10, will yield no identical tin or lead particle by virtue of a fusing temperature. Copper, 80; tin, 10 and lead, 10 will yield no copper, tin, nor lead particle while the influence of the affinitive tin is equal to or greater than the copper-lead opposition. In copper, 80 and lead, 20, the lead will seek isolation when the alloy is exposed to its fusing temperature.

By virtue of the different types of union, there arise two distinct classes of alloys; perfect and imperfect. A perfect alloy is the direct result of a chemical union; an imperfect one in which two or more elements do not chemically combine.

In the perfect alloys there are also degrees of perfection. The voluntary chemical union of all constituents represents the highest type of an alloy. It is not to be supposed that the superinduced union, even though chemical, will measure up to the same homogeneous *oneness* in composition as will a mix in which all constituents are affinitive to each other. The degree of perfection in any alloy is proportional to the average degree of affinity between its constituents. Thus, copper, 88; tin, 10, and zinc, 2, represents a more perfect alloy than copper, 80; tin, 10 and lead, 10, because copper, tin and zinc all have individual and combined tendencies to affiliate, whereas in the copper-tin-lead alloy the lead and copper are affinitively estranged and must draw on the tin in consequence of which the affinitive qualities of both tin and copper are weakened. From the nature of alloys in general, the strong influence which small percentages of one metal often have on another and the close qualititative demands with which the product must comply, it is apparent that the formula of a non-ferrous alloy is no guessed-up affair.

In determining the constituency of those native to the brass foundry the practice of evaluating an individual content approximately by judgment or supposition has given place to that of a definite calculated figure. This implies careful reasoning and close figuring.

Every process of reason rests on a basis of comparison, some unit to and from which the mind can operate in reaching its conclusions. In deducing truth from truth it is essential that we understand thoroughly and in closest detail the elements of the known truth; these elements being the premises to the reasoning process.

Copper as Basic Element

The majority of brass and bronze alloys admit copper as their basic element. In its virgin state this metal qualifies with reasonable satisfaction in the minority of cases only. It is difficult to cast, hard to machine, highly susceptible to frictional heat, comparatively high in compression, strong in malleability and weak in corrosive resistance. With these and other qualities against

it, however, it makes a good body and possesses the happy property of accepting and yielding to the modifying influences of auxiliary agents. It is the judicious introduction of these agents that constitutes the logic of a good alloy.

After all, a copper basic alloy is merely a substitution elimination, elaboration or diminution in the copper properties. In other words the modifying agents are the means to an end to which copper either fails entirely to measure or only partially attains.

Getting down to brass tacks then, copper is the simple subject and the alloy the modified subject. The qualities of copper as affected by the modifying agents in some known alloy is the basis of comparison in reasoning to some desired alloy of stipulated requirements; or, more briefly, we must reason to and from the copper in its known susceptibility to change.

General and Specific Properties of Metals

Metals possess both general and specific properties. The general properties vary in degree of prominence in different metals. Many specific properties common to different metals vary in degree also. A consideration of the properties of different metallic elements and the degrees of prominence in each is a great study for the man of alloys. Yet it is not his only problem. An alloy were indeed a simple affair if the specific properties of all metals would combine to the happy medium in their alloys. It were still no very difficult problem if like would always produce like and opposites always conform to general principles and uniform rules of conduct in combination.

Consistency of laws governing qualitative results from mixing were a jewel indeed if it only *were*. But it is not decreed that it should be and the combination assumes additional complexity in consequence. Generally considered, two or more metals of opposite, similar or varying specific properties will often combine to form a product in respectable qualitative ratio to the qualitative and quantitative prominence of properties in the elements combined; though this rule will find quite as many exceptions as applications. It holds active with tin and lead, but betrays falsity with lead and antimony. It is fairly active with lead and copper or zinc and copper, but seems to exercise no jurisdiction over a combination of tin and copper. These elements possess some qualities in common, the most prominent of which is malleability. By combining tin, an element between lead and zinc in hardness with copper we would naturally expect in the alloy pronounced malleability and a hardness at least no greater than that of virgin copper. Least of all would we expect from copper, 84 and tin, 16, a product excessively hard and practically void of all malleability and flexibility, such as is found in the bell metal of this constituency.

It is within the domain of reason that 12 per cent nickel will produce the stability native to the United States "copper" cent, but not in keeping with the naturally conceived order of things that 10 per cent copper with 90 per cent gold or silver, all three of which are distinctively malleable, will produce coins in which malleability and flexibility are so much suppressed.

But we must get back to a copper base. In the following brief consideration of the more common copper-modifying agents we wish to state that the figures being general in character, must be considered not altogether specific in value and that our statement regarding the affinities and judicious use of metals are true in many cases in ratios only that will satisfy practical requirements. We would also state that, in the main, these statements are of foundry rather than textbook extraction.

The elements most common to a copper basic alloy are tin, lead, antimony, zinc, aluminum, phosphorus, magnesium, nickel, manganese and silicon. Each of these has a function of its own while derived functions often arise from combination.

Properties of Tin

Tin is a brilliant appearing white metal whose molecules resist disturbance in bending with sharp resistance and a creaking noise. It has a powerful and almost perfect alloying nature, evidence of which is the fact that it will seek and maintain surface adhesion to many metals even when those metals are in solid state, as in the tinning process prior to soldering copper, brass, iron, steel, etc. Further emphasis of this tendency can be noted in the additional fact that different metals of affinitive variance can often be persuaded to mix to efficiency through its influence. Its value is so thoroughly recognized that its price, however high, is seldom prohibitive and it is to be found in almost every copper basic alloy where its influence is required.

The effect of tin on copper is to harden, strengthen, give sounding quality, diminish toughness, reduce adhesion, support incorporation of other ingredients and to aid in corrosive resistance. Examples of the tin-copper alloys are old gun metal, copper, 90 and tin, 10, and the bell metals as copper, 85 and tin, 15; copper, 80 and tin, 20, etc. The evils to be guarded against in tin-copper alloys are excessive hardness in quality and high temperatures in practice. Being a low degree melting constituent, it should never be added before the copper content has been reduced to a liquid state. These alloys usually give best results in casting at a low temperature. The range of practical efficiency for tin lies between 2 and 20 per cent.

Lead is a dull-colored white metal whose molecules offer lifeless resistance to disturbance in bending. It is a dead metal and practically a negative constituent. Its effect on copper is to soften, eliminate adhesion, diminish wearing and heating tendency and reduce frictional qualities. Recently delivered opinions based on experiment seem to indicate that lead tends to support tensile strength. Personally we are in a position to neither support nor condemn the contention and for further information would refer the reader to the findings of Dewrance.

Its affinitive qualities are far less marked than those of tin, though they respond to the influence of tin with which it alloys perfectly. It renders castings more congenial to the machine tool and for this reason alone is sometimes added. Its most useful application is in the bearing alloy, though to insure incorporation in copper above 4 per cent of its own quantity requires some auxiliary agent. The value of tin in this connection is well established and in consequence from 12 to 15 per cent of lead can be controlled. Contention has it that special foundry manipulation will control lead in copper at any figure. We confess ignorance to the process of said special manipulation, with or without sulphur. A still further useful property of lead is its corrosive resistance in the presence of certain acids; with ½ to 2 per cent of antimony to harden it, it becomes shape-retaining and useful in different instances.

The practical range of lead efficiency in copper depends upon the function of the individual alloy. Beginning at 2 per cent, it extends to almost any figure within which the lead can be controlled. We can conceive judicious applications of a lead and copper mix ranging up to 50 and 50, providing the union of the two elements is either chemical or mechanically perfect and not superinduced by some agent detrimental to the welfare of the alloy.

Antimony

Antimony is a bright-colored white metal of crystalline body, whose particles part in attempt at bending. It is practically void of both tenacity and malleability, is brittle, granulates under pressure and is endowed with anti-frictional qualities. Its effect on copper is to harden, weaken and reduce friction. It is sometimes used as a substitute for

tin though most inadvisedly so. Carrying its virgin properties unimpaired into the alloy it produces a hard, brittle, treacherous casting. Alloyed with copper as a base it has no range of practical efficiency though its effect can be noted at any figure however low that figure may be.

Antimony finds it most useful application alloyed with tin and lead in the white metals such as babbitt, filling metal, metallic packing, etc. In these lead or tin constitutes the base and sometimes admit a low percentage of copper along with the antimony. The ranges of practical efficiency of these metals in composition are: Copper, 1 to 3 per cent; tin, 10 to 90 per cent; lead, 70 to 90 per cent and antimony, 5 to 15 per cent as per the following:

Tin, 90; antimony, 8 and copper, 2; medium hard, malleable and anti-frictional.

Lead, 85, and antimony, 15; hard, not malleable, brittle and anti-frictional.

Lead, 86; tin, 7 and antimony, 7; hard, tough, slightly malleable and anti-frictional.

From this we can conclude that antimony destroys malleability in lead, reduces it in tin and lead combined, but is forced to arbitrate in the presence of tin alone or tin and copper combined with tin as a base. Such is the despotism of tin over its alloyed associates.

Zinc

Zinc is a gray-tinted, white metal whose particles congregate in prismatic clusters. The exteriors of these clusters or prismatic forms are smooth and form a sort of parting. The molecules of the cluster cling to each other with a singular tenacity though cluster can be separated from cluster with reduced difficulty. These molecules possess the quality of toughness and heating tendency. The effect of zinc on copper is to close the grain, impart a quality of toughness not native to the copper element and to modify color. Its range of practical efficiency in an alloy is from 2 to 35 per cent. In union with copper (as copper, 88 and zinc, 12) it imparts to the alloy its own peculiar toughness and closes the grain, at the same time neglecting the subdued rigidity essential to many requirements.

Combined with tin and copper, zinc yields a close-grained product of stiff body, as can be noted in the modern gun metal—copper, 88; tin, 10 and zinc, 2—and applies with advantage to gear wheels, feed nuts, valve stems, etc.

Reversing the values of the tin and spelter we have copper, 88; zinc, 10 and tin, 2, and an alloy still tough, but of less stiffness and adapted to requirements where rigidity is of less consequence. By lowering the copper, slightly raising the tin and zinc and adding ½ per cent of lead, we have copper, 85½; tin, 10½; zinc, 3½ and lead, ½, constituting a good hydraulic pump mixture. By combining equal parts of tin and lead with zinc equal in quantity to the combined tin and lead, we arrive at copper, 84; zinc, 8; tin, 4 and lead, 4 and an alloy of good body, close grain, medium toughness, excellent machining qualities and up to standard as a reliable steam metal. From these figures as a base a wide range of qualitative variation can be reasoned to.

Yellow Brass

Copper and zinc, 2 to 1, (copper, 66 2-3 and zinc, 33 1-3) constitute the ornamental or yellow brass alloy. Variation in color can be realized by regarding the zinc the controlling agent and varying its content accordingly. To the zinc-copper alloy equal parts of tin and lead in very small amounts are sometimes added to improve the individual and machining qualities.

From the foregoing it will be noted that tin diminishes the toughness of copper up to probably 12 per cent of a tin content and thereafter practically eliminates it. Zinc, however, refuses to yield to the demands of tin and supplies a more substantial toughness to remunerate the copper for its loss at the hands of the tin. Thus the old gun metal, 90 and 10, is too rigid for many purposes and finds its more adaptable qualities in the 88 copper, 10 tin, 2 zinc alloy. This, however, is still too stiff for other requirements and to realize further moderation the tin is reduced and the zinc raised as in the formula 88 copper, 10 zinc, 2 tin. This also has its shortcomings in different applications and must be still further modified. Some desired quality or moderation is lacking in all combinations of tin, zinc and copper and we must seek either a substitute or an antidote. What we want is to reduce toughness to good finishing consistency and still retain necessary hardness and strength. To realize this we raise the tin, lower the zinc and copper and add lead as in 84 copper, 8 zinc, 4 tin and 4 lead.

The introduction of zinc into a copper basic alloy should be executed with the maximum of foundry precaution. Few elements are more susceptible to the evils of bad practice. Subjected to high temperatures or long periods of medium temperature, the zinc assumes a gaseous state and passes off in dense fumes. The snowy whiteness often observed at the top of brass foundry furnace stacks is largely the sedimentary deposit of these fumes. Analysis of high zinc castings has evaluated a zinc content less than two-thirds the introductory figure. To minimize this evil the zinc should be added just prior to pouring and at the instance of its introduction the copper content should be covered with a thick layer of crushed charcoal or dry sand to direct the escape of the fumes.

There is a combined strength and toughness not furnished by copper nor elaborated through tin and spelter; a sort of stubborn resistance the destruction of which a fusing temperature of the alloy alone will entirely accomplish. Such a quality is that native to the aluminum bronze. Aluminum is a light-colored metal of low specific gravity whose molecules offer respectable resistance to disurbance in bending and part only after continued disturbance. It is strong in tenacity, medium in hardness, high in malleability and fair in alloying tendency. Its effect on copper is to raise tensile strength and to toughen. Its range of practical efficiency is from 2 to 10 per cent. An aluminum bronze consisting of copper, 90 to 95 and aluminum, 5 to 10, is of special service in gear wheels, clamps and all cases where strength and tenacity are required. This metal, however, has more than one casting difficulty. Its tendency to shrink and draw is pronounced and should be intercepted by large running gates and ample sprue pressure. Much also depends on casting temperature.

Oxidation of Copper

To the oxygen of the air there is no mark more shining than a body of molten copper-basic metal. Contact between the two results in an oxidized product and it develops in spite of most precautionary measures. The brass man's only recourses are to minimize atmospheric contact as far as possible, drive the oxides to that part of the casting where they will do least damage and introduce counteracting agents wherever admissable.

Phosphorus is a deoxidizing agent. It is to metal what white corpuscles are to blood. The effect of its introduction is noted in a cleaner, harder metal apparently more liquid in its molten state. Its use, however, is a foregone blessing in many instances. Zinc will not tolerate nor will excess lead contentedly abide its presence. In most cases phosphorus is introduced into the alloy through copper or tin as a medium, these elements thus being designated phosphor-copper or phosphor-tin and are usually combined on a 5 or 10 per cent phosphorus basis. The more common applications of phosphorus are in the low lead bearing and acid metals as copper, 80; tin, 10; lead, 9 and phosphorus, 1, and copper, 93; tin, 6½ and phosphorus ½. Its range of practical efficiency is low, being from ½ to 1 per cent.

An ocular demonstration of this effi-

ciency can be realized through a critical comparison of the surface of a copper-tin-lead alloy both with and without a phosphorus complement. In the former the surface is sluggish and *scummy*, constantly developing a brown or black perforated sheet of oxidized metal, resembling a sheet of paper burned to ashes and retaining a semblance of the sheet form. This *scummy* surface is not native to the metal such opinion being evidenced by the fact that a *peep* beneath the surface of a substantial crushed charcoal or dry sand protection from atmospheric contact reveals a clear, liquid metal surface.

In the metal with the phosphorus complement the surface unprotected is clear and liquid. This, however, does not warrant manipulating the metal without surface protection since the greatest precaution is little enough. Instead of a scum, small brown specks attractively inclined and in considerable commotion appear on the surface chasing each other around and finally combining in a large brown cake resembling a scab. This metal pours free and liquid at a reasonable temperature and returns to its solid state through successive degrees of granular construction.

The tendency of phosphorus is to sand-burn the casting, and to guard against this evil the mold and all cores should be well faced with a substantial product such as plumbago or red talcum and the metal poured at a temperature critical to the production of solid castings and the elimination of sand burning. This temperature varies with the quality of the metal and the weight of the casting in ratio to its surface area. For small and chunky castings weighing say 10 pounds, that temperature at which good metal begins to assume a thin, syrup-like state will be found not far amiss. For the larger, chunky castings weighing from 100 to 200 pounds the first evidences of the granular state of the metal, in the majority of cases, can be safely taken as the proper pouring temperature.

Magnesium is another element possessing deoxidizing properties. Its tendency, however, is to superinduce brittleness in the casting. This feature is so pronounced and serious that good judgment warrants only that quantity absolutely necessary to deoxidizing requirements. This quantitative figure usually lies between 0.02 and 0.06 per cent.

Nickel is a light-colored metal whose molecules rigidly resist disturbance in bending and part soon after the application of sufficient force to overcome this resistance. The molecules in themselves combine strength and hardness. Its effect on copper is to diminish toughness, harden, strengthen, modify color and increase resistance to atmospheric corrosion. In addition to these, claims are made that nickel will support incorporation of lead in copper up to 30 per cent of a lead content. The object of this article is to neither support nor condemn contentions and we pass these claims with a mere expression of our candid opinion that above 18 per cent of lead and 4 per cent of a tin content, nickel from ½ to 1 per cent is not to be seriously considered. Nickel finds judicious application in ornamental and strength-possessing metals such as German silver and the nickel bronzes. The former is noted for its durability and corrosive resistance; the latter for its strength. An example of the German silver alloy is copper, 62; nickel, 18 and zinc, 20; of a nickel bronze, copper 85½; tin, 10, nickel, 4 and phosphorus, ½. In combination with tin, lead and copper in the low or medium lead bearing alloys, a trace of nickel will increase strength and improve quality. Claims have been made that nickel in low percentages liberate gases superinducing porosity in the casting though we are not personally aware of difficulties in this particular that good foundry practice will not intercept. The range of practical efficiency of nickel in copper is from 1 to 10 per cent of a nickel content.

A FEW FACTS ABOUT IMPORTANT METALS

Metal.	Symbol.	Color.	Nature.	Alloying tendency.	Fusing temperature, deg. Cent.
Copper.....	Cu	Red	Flexible, hard, tough, adhesive, ductile, malleable.	Strong	1,060
Tin.....	Sn	White, lustrous	Soft, malleable.	Strong	233
Lead.....	Pb	Bluish-gray	Soft, malleable.	Weak	327
Antimony...	Sb	Silvery-white	Crystalline, brittle.	Fair	625
Zinc.....	Zn	Bluish-white	Body brittle, particles tough.	Fair	420
Aluminum..	Al	Lustrous	Ductile, malleable, tenacious.	Fair	660
Magnesium.	Mg	Silvery-white	Tenacious, ductile.	Fair	633
Nickel.....	Ni	White	Hard, ductile, tenacious, non-corrosive.	Strong	...
Manganese.	Mn	Grayish-red	Hard and brittle.	Strong	...

Manganese

Manganese is a hard, brittle metal, grayish-red in color and resembles cast iron in appearance. Its effect on copper is to harden, toughen, strengthen and increase durability. Manganese bronze is an alloy representing these qualities in their highest state. A conception of gun metal (88-10-2) with its distinctive qualities raised to their highest power will furnish an idea of good manganese bronze. In its earlier stages the product seems to have arisen from the addition of manganese (from 1 to 3 per cent) to the ordinary copper-zinc or copper-tin-zinc alloys. More recent development, however, claims advantage in the addition of nickel, aluminum and iron. When thus combined and properly manipulated all the rigid toughness and strength of the metals introduced combine to greatest efficiency in the alloy. The metal finds judicious applications in sheathings, gears, propellers and all cores where high strength and durability are in demand. Its range of practical efficiency is from ½ of 1 to 2 per cent. A formula covering—Copper, 67; zinc, 30; manganese, 1; tin, 1; aluminum, ½ of 1; iron, ½ of 1.

Silicon is a non-metallic element used to reduce the casting difficulties of copper or exceedingly high copper alloys. It is more in the nature of a flux than a constituent. Its effect is to overcome the agitated and porous casting tendencies of molten copper without changing its virgin properties. The nature of molten copper is to boil; its casting tendency to shrink and vacate the mold through the pouring gate thus creating porosity and cavity in the casting. The presence of silicon calms the troubled metal and prevents the internal disturbance by virtue of which the metal would in part return through the gate. The quantity used is a matter of judgment, the behavior of the molten mass dictating the amount.

That the efficiency of an alloy is closely related to its judiciously selected constituency is a foregone conclusion.

Success in realizing a high class product, however, does not ultimately depend on the judicious make-up of its constituency. Much remains for intelligent foundry manipulation to take care of in obtaining an efficient alloy. Such manipulation may in part be the outgrowth of experience though many of its features can be located in the domain of common sense.

To specialize in complete detail on this phase of the question were a task too long and beyond our limited ability to even attempt. A few general suggestions, however, may not be out of place and will serve to illustrate more clearly the importance of the consideration. In realization of the best possible results the following will be found factors of no mean significance:

1.—In selection of virgin material, reputable brands only should be considered. Poor material will baffle the most careful manipulation and best foundry practice.

2.—Every alloy should contain at least 30 per cent new material. The marked deterioration in quality of metal arising

from remelting makes the addition of new a strict necessity.

3.—All new material should conform to specifications covering impurities and foreign ingredients.

4.—Accurate and definite figures representing the consistency of all scrap product should be at hand; guesswork is poor policy.

5.—No alloy should be subjected to temperatures above that necessary to its casting or mixing state, nor exposed to that temperature long.

6.—In combining low with high-degree melting constituents, the former should not be added until the latter has been reduced to a liquid state.

7.—In introducing an element whose melting point is considerably above the melting point of copper, the better method is to introduce it through copper as a medium as nickel through nickel-copper; manganese through manganese-copper, etc.

8.—In combining three or more elements two of which are affinitive to each other and one of these two at variance with the third, most satisfactory results follow the introduction of the two affinitive elements in combination. Thus tin and lead in 80, 10 and 10, will incorporate better when introduced in combination at 50 and 50 than they will by finding each other in the mass after being separately introduced.

9.—In making an alloy whose completed content includes two or more elements of high melting temperature, a separate alloy should be made by combining these high degree elements, with or without copper, as the case may warrant, and thus introducing them, the object being to lower the melting point, insure better incorporation and protect the low degree elements from the excessive heat in the manipulation of the naked high. Thus, in manganese bronze, a separate and pre-prepared alloy of manganese-iron-copper or manganese-iron-tin constituency, introduced into a molten copper mass to the whole of which tin, zinc and aluminum are added later will indicate better practice than that involved in combining the entire manganese, iron, copper or tin content direct. In using tin instead of copper in the above pre-prepared alloy it must be understood that its sole object is to lower the melting point, that much of it is lost in first manipulation and that this loss must be corrected with an increased tin content in the completed product.

10.—An iron skimmer or stirring rod should never be immersed in a non-ferrous liquid when the temperature of that liquid approximates the fusing point of iron.

In the foregoing we have aimed to cover a few practical points in the more common copper-basic alloys. That we have left many important considerations without notice must be charged to conservation of space and the narrow limits of any one man's experience. We have done little more than open on a subject so vast in its scope that to cover in minute detail would be a task to which many minds would need contribute.

We have used the term *chemical union*, not ignorant of the fact that such a union in a scientific sense is more conceptive than real. The atoms of few differing metals combine in the mass they produce in strict ratios to their introductory figures and such a combination is essential to a strict chemical union. We have used the term in a comparative sense only. The term *perfect alloy* also must be considered in this sense. The term *base* or *basic* we have used in a quantitative sense only and not with reference to any critical or relative qualitative points in the elements referred to. By the term *mechanical* or *physical process* we have referred to any process that does not involve chemical change, electricity or heat in advance of that necessary to a fusing temperature of the alloy or elements under consideration.

The accompanying table will give a few condensed facts in connection with the metals referred to.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Piston Ring Mixture

Kindly advise me whether the following mixture is satisfactory for spring rings for pistons: Copper, 55.30 *per cent; zinc,* 43.50 *per cent; tin,* 0.07 *per cent; lead,* 0.06 *per cent, and iron,* 0.95 *per cent.*

We doubt very much whether the mixture mentioned will prove satisfactory for this work, as rings made from it will be liable to cut and score the cylinder. A piston ring is practically a bearing and the highly-leaded alloys have been found the most satisfactory for such purposes. An alloy containing 50 per cent copper and 50 per cent lead is used extensively for piston rings at the present time. Obviously, such an alloy cannot be used as a spring, and, therefore, the contact between the ring and the walls of the cylinder must be maintained independently of the ring which merely serves the purpose of a sliding bearing. When a piston ring must maintain contact with the walls by its own resiliency, the following alloy generally is employed: Copper, 83 per cent; tin, 10 per cent, and zinc, 7 per cent.

Brass Mixture

What metal mixture would you suggest to resist carbon dioxide at a pressure of 100 *pounds?*

No special alloy is required to withstand carbon dioxide at so low a pressure and almost any copper alloy should be satisfactory for this purpose, provided, of course, that the castings are of sufficient thickness to resist a pressure of 100 pounds per square inch. Incidentally, the castings also should be free from porosity. Carbon dioxide will not attack copper or its alloys even when the latter are in a molten condition and as a matter of fact, it is used as a protective covering for copper, brass and similar alloys while they are being melted. This gas is evolved from the charcoal used as a cover on copper alloys while the melting operation is in progress. The following mixture should give you satisfactory results: Copper, 87 pounds; tin, 7½ pounds; zinc, 3½ pounds and lead, 2 pounds.

The copper should be melted under charcoal and care should be exercised to avoid the possibility of having pasty metal. This can be ascertained by parting the charcoal on the molten surface with an iron bar preparatory to the introduction of tin, zinc, etc. The copper should be limpid and clear underneath the charcoal, and if this condition prevails, a small piece of zinc should first be added and should be stirred well into the copper. Then follow with the balance of the zinc, next the tin, then the lead and stir well be-

fore pouring into the molds. If pasty metal appears on the surface of the molten copper, add 4 ounces of phosphor-copper for each 100 pounds of metal. The phosphor-copper should be broken into small pieces and should be scattered onto the surface of the copper, after which it should be stirred into the metal. If the pasty metal then does not disappear, make a second addition of 4 ounces of phosphor-copper.

Mixture for Street Railway Brasses

Can you recommend a good mixture for electric street railway brasses? If possible, give a formula in which a large amount of scrap brass can be used.

Several alloys are being used in electric street railway service, as follows:

For axle, journal and motor bearings—Copper, 38½ per cent; tin, 4 per cent; lead, 7½ per cent and scrap brass, 50 per cent.

For trolley wheels, car trimmings and power house castings.—Copper, 62 per cent; tin, 3.80 per cent; lead, 1.90 per cent; zinc, 2.30 per cent and scrap brass, 30 per cent.

For steam fittings of all kinds.—Copper, 59½ per cent; tin, 3½ per cent; lead, 3½ per cent; zinc, 3½ per cent and scrap brass, 30 per cent.

For miscellaneous castings.—Copper 67 per cent and zinc, 33 per cent.

Removing Iron From Brass

What flux should be used to remove iron from brass?

The best method of removing iron from brass is by means of a magnetic separator. However, if the iron is contained in the brass, a magnetic separator will not serve your purpose. In such a case it would be advisable to sell the brass to a refiner, as you will find it difficult to remove the iron in a crucible, especially when zinc and other easily oxidizable elements are present.

Mixtures for Builders' Hardware

We would like to obtain a mixture for a good red brass or bronze for making builders' hardware. Great strength and wearing qualities are not as important as a red metal that will finish well and one that can be made at comparatively low cost.

A good mixture for cheap builders' hardware follows: Copper, 84.21 per cent; zinc. 10.53 per cent; tin, 2.63 per cent and lead, 2.63 per cent.

For the better grades of builders' hardware the following alloy is used: Copper, 87.43 per cent; tin, 8.2 per cent; zinc, 2.2 per cent and lead, 2.2 per cent.

Acid-Proof Bronzes

Kindly give us several mixtures for acid-proof bronze, as well as bearing brasses.

In making acid-resisting bronzes the following alloys frequently are used:

Copper, 90 per cent and tin, 10 per cent.

Copper, 85 per cent; tin, 10 per cent and lead, 5 per cent.

Copper, 80 per cent; tin, 10 per cent and lead, 10 per cent.

For bearings the following alloys will give good results:

Copper, 65 per cent; tin, 5 per cent and lead, 30 per cent.

Copper, 78 per cent; tin, 7 per cent and lead, 15 per cent.

Copper, 88 per cent and tin, 12 per cent.

Bearings for Machine Tool Spindles

We are engaged in the manufacture of bronze bearings for high grade drill presses and we would like to know what mixture will give the best results, regardless of price. The bearings are for the spindles of a press which operates at various speeds, sometimes as high as 2500 revolutions per minute. The bearings which we furnished to this drill press manufacturer begin to show wear after eight or nine months' service. We have been advised, however, that these bearings are expected to last for many years.

The mixture which we use for these bearings follows: Copper, 80.5 per cent; zinc, 4 per cent; tin, 8 per cent; lead, 7 per cent and phosphorus, 0.15 per cent.

Recently we changed our mixture to conform to the following: Copper, 81 per cent; zinc, 2 per cent; tin, 10 per per cent; lead, 8 per cent and phosphorus, 0.25 to 0.30 per cent. Do you think it advisable to eliminate the zinc and increase the percentage of lead? Also, we would be pleased to receive several analyses of standard bronzes used in the machine tool industry for bearing purposes. We desire not only the very highest grade, but some of the commoner kind.

The best material that can be used for the purpose outlined is a 10.5 per cent aluminum bronze, which should be drop forged. This alloy is cast into bars of the requisite size and these are forged hot to close the grain. However, aluminum bronze is so difficullt to cast that without previous experience with this alloy, it is doubtful if satisfactory bars could be made. Both the alloys mentioned should give good results for bearings, but it is advisable to omit the zinc in both cases as there is sufficient phosphorus to prevent porosity.

The following alloy can be recommended for your use: Copper, 81 pounds; phosphorus-copper, 2 pounds; tin, 12 pounds and lead, 5 pounds. An alloy not quite so expensive as the one previously mentioned consists of copper, 75 per cent; tin, 8 per cent; lead, 15 per cent; and phosphorus-copper, 2 per cent.

Soldering White Metal

Can you advise us how to solder a white anti-friction metal, consisting of zinc and tin in about equal quantities, onto brass and composition car brasses? We are experiencing considerable difficulty in having the white metal adhere to the brass, as it does so only in spots. We have tried several different soldering fluids, but without satisfactory results.

The bearing of the car brass will have to be tinned before the white metal will adhere and the first essential to successful tinning is to bore out the car brass journals. Unless this is done the lining will adhere only in spots as indicated in your inquiry. Special machines are built for boring-out car brasses and these are designed to permit of boring-out several pairs of journals in one operation. After the brasses are bored, the journals are swabbed with chloride of zinc flux and then are dipped into a bath of solder. In practice, the bearings usually are dropped into the bath of solder and are removed as required. When taken out of the bath the bearings are hot and the bored section is rapidly wiped off with a piece of waste, leaving the surface smooth and brightly tinned. Only the parts that have been machined and treated with the flux will take the solder. The bearings then are clamped to a mandrel and the white metal is poured into the space between the bearing and the mandrel and adheres firmly. It is customary, however, to employ antimonial lead for lining car brasses and even pure lead is sometimes employed. We doubt if any advantage will be gained by using an alloy of zinc and tin. In any event, the latter alloy can be used for tinning the bearings, as this work will have to be done with solder and the white metal then is poured onto the soldered surfaces of the bearings.

Trolley Wheel Mixture

Kindly give us a mixture for trolley wheels.

The following alloy will be found satisfactory for trolley wheels: Copper, 92 pounds; tin, 6 pounds and phosphor tin, 2 pounds.

First melt the copper under charcoal, add the phosphor tin, stir well and immediately before removing the crucible from the furnace, add the tin and stir again.

Protective Coatings for Iron and Steel

By E P Later

PERHAPS the title of this article is rather broad and indefinite and, in a way, it is, but it is believed that there is need of wider knowledge, among platers and those engaged in similar lines, of the comparative efficiency of the different finishes which are applied to iron for protective purposes, with a better understanding of their possibilities, limitations, etc. Nearly every day the writer is asked some of the following questions: "Should I put copper or nickel on this part?" "Is zinc any better than copper?" "Will sherardizing injure this part?" "How can I determine if I am getting a deposit sufficiently heavy to insure the protection I want?" and so on, *ad infinitum.*

The designer frequently goes to the plater seeking such information and, while the latter may know how to produce any finish that is desired, in a surprising number of cases he does not know much about their actual protective values nor how to determine if an effective coating has been applied. In an article of this length it is obviously impossible to go into minute details regarding all of these points, but it is hoped that the facts herein stated may be of some assistance to those readers of THE FOUNDRY who are confronted with similar questions. It will be well to state that only those finishes which are applied primarily for protective reasons will be considered.

Tin, copper, nickel and zinc are the metals which are most widely used in this connection at the present time. All of these may be applied by electrolysis and all, with the exception of nickel admit of application in other ways.

Tin, for several reasons, is not plated to any great extent. It is fairly expensive and does not offer any particular advantages over some of the cheaper metals. Large quantities of it are used, however, in the manufacture of tinned sheet iron. The coating in this case is produced by dipping the sheets in a bath of the molten metal, as in the familiar hot galvanizing process. Some kitchen ware, such as stew pans and food choppers, are given a tin dip. The coating on terne plate varies in weight, but is generally fairly thick. It is always porous, however, and a sheet of this material will develop rust in a few days, when exposed to the weather. Tinned cooking utensils seem to behave better, for some reason or other, and will remain in good condition indefinitely.

Sometimes, parts are given a very light deposit of tin by boiling them in a solution of certain salts of this metal, but the protection afforded thereby is so slight that it amounts to almost nothing.

Altogether, tin is applied more often by the hot dip method, which generally does not come under the direct supervision of the plater. The disadvantages of this process will be taken up later.

Use of Nickel

Nickel is used extensively in electroplating and is applied to a great variety of parts, both for the sake of appearance and protection. As a matter of information for anyone who may not know it, nickel is deposited from a bath composed of either nickel sulphate or nickel-ammonium sulphate, a very slight amount of free sulphuric acid being present, together with boric acid, to assist in the production of a good deposit. Nickel has good resisting powers toward corrosive influences and remains in very fair condition even under severe exposure.

A nickel throws reasonably well, that is, a fairly satisfactory deposit is obtained in the recesses and corners of the parts and heavy coatings are easily formed on exposed surfaces. For protective purposes, a deposit of 10-15 milligrams per square inch will generally suffice for parts which are not subjected to outdoor exposure or situated in very damp places. At this rate the dimensions of the parts are increased so slightly that the difference is negligible. For parts, however, which demand better protection, being exposed to more severe conditions than the other, a deposit of 40-50 milligrams per square inch should be applied. On fine instruments and parts which are accurately machined and fitted, some allowance may have to be made for the increase in size which is occasioned by a deposit of such weight. It may be remarked that in a case where so much nickel is required, it is cheaper to make the bulk of the coating copper and then, if it is desired, finish with a few milligrams of nickel. As far as known, the protection afforded by both copper and nickel is entirely mechanical, that is, they act by excluding air and water, and neither appears to be superior to the other, considering deposits of equal weight.

Space does not permit a description of the method of determining the weight of nickel on a part, although such a test is often required. Detailed methods for the estimation of the different metals used in plating were given in THE FOUNDRY some months ago, and it is suggested that they be referred to in this connection.

Copper also is used extensively as a means of protecting iron and steel

parts from corrosion. They are, of necessity, plated in a so-called cyanide bath, which is made up of a basic carbonate or sulphate of copper dissolved in a slight excess of potassium, or sodium cyanide.

Copper tarnishes more easily in the air than nickel, a fresh surface soon becoming covered with a thin coating of oxide and basic carbonate, but this layer protects the rest of the metal from further attack. When it is desired to keep a copper deposit its original color for the sake of appearance, it is lacquered. For this reason nickel has some advantage over copper in that it is seldom necessary to lacquer parts which have been nickelplated. Such a proceeding means, of course, an extra operation and increased cost. In other respects, however, most of the remarks made about nickel will apply as well to copper, that is, a deposit of at least 15 milligrams per square inch should be applied in order to insure thorough protection under ordinary conditions, while 50 milligrams, approximately, are required for parts under severe exposure. Various pieces of electrical and other apparatus are often copper-plated before the application of one or two coats of a baking japan, the idea being to secure a more efficient protection than would be given by either of these coatings alone.

Copper solutions are easily operated and *throw* well so that any class of parts which admits of plating at all may be given a satisfactory deposit.

The weight of a copper coating can be estimated with the greatest of ease in a few minutes by cleaning and carefully weighing on a delicate balance a small part, or section of one, then stripping the copper off in a strong solution of potassium cyanide, which will not attack the iron. When the coating is entirely removed the part is washed, dried and weighed again. The difference in the two weights represents the amount of copper which had been deposited on the part and by dividing this by the area in square inches and moving the decimal point three places to the right, the result is expressed in milligrams per square inch.

It is interesting to note that copper-clad steel is being used to some extent. There are two methods of producing this; in one, the copper is molten, in the other, it is heated only until it becomes plastic. The product, in either case, is material in which the two metals are firmly united together, through the formation of alloys.

Use of Zinc

Coming now to zinc, it is found that the application and use of this metal is in various ways markedly different from the other metals which have just been considered. In the first place it admits of application by three totally distinct methods: Hot dipping, electro-galvanizing and sherardizing. So far as known to the writer no other metal can be deposited by this latter process. And then, the protection of iron by zinc is of a two-fold nature. It acts mechanically, excluding air and moisture in the same way as nickel and copper, but in addition there is a very definite physical and chemical action. To understand this a little explanation will be necessary. Briefly, the corrosion of iron is accompanied by the evolution of hydrogen and other evidence of electrolytic action and the electrolytic theory of this process postulates that corrosion is attended by a flow of current from the points of high potential to those of low potential, or from electro-positive to electro-negative poles. It can be shown that every iron surface or part tends to develop these poles of opposite polarity and further, that in the presence of conditions favorable to corrosion, the spots which are electro-negative are protected at the expense of the electro-positive spots, which are corroded rapidly, a current flowing meanwhile from the latter to the former. Perhaps this may be made clearer by roughly comparing this action to that which takes place in a plating tank. In the latter the current flows from the anode, electro-positive, to the cathode, electro-negative, and the anode is dissolved while the cathode is protected.

Going a little farther, it should be easy to see that if we can combine or join the iron with some metal which is strongly electro-positive to it and then expose such a couple to corrosive agents, a current will flow from the more positive metal to the iron, with the result that the latter will be protected while the other will suffer in some way. Now this is just what takes place when iron is coated with zinc. This is electro-positive to iron, so when in the course of time a galvanized coating breaks down so that air and moisture can get to the iron, a current is set up and flows from the zinc to the iron, which is thereby protected, as previously explained. There are other metals which are more electro-positive to iron than zinc, but they are not adapted physically for use as protective coatings, so zinc has no rivals along this line. It must not be inferred that a zinc coating is perfect or lasts forever, since it is plain from the foregoing that it will eventually be so disintegrated that it can no longer protect the underlying iron and corrosion of the latter will take place, but this fact does not lessen the value of the metal as a preservative agent and enormous quantities of it are used yearly for this purpose.

(*To be continued.*)

Results Accomplished by Scientific Management-II*

By Seymour W Rowsbar

IN MANY shops the firm would be well repaid in a few weeks for a reasonable outlay on suitable equipment. Very few plants cannot utilize both the mechanical plating apparatus and the electric cleaner, two of the modern improvements which are wonderful aids toward economy and plating room efficiency. To competently operate the mechanical plating machine the plater must study the effect of the treatment on the various shapes and sizes of parts plated by this method so that uniform results may be obtained on all similar pieces from time to time. Experience alone will teach him how to load for best finish. Then the speed is important and the time allotted for the deposit must be sufficient to meet the requirements of the firm. A 60-minute deposit of nickel obtained in a perforated cylinder from a solution of 10 or 12 degrees Beaume density, using 70 to 90 amperes at a pressure of 3½ to 5 volts, and treating six quarts or more of pieces each load does not afford protection to iron or steel exposed to atmospheric influences in the open or to wear under the most favorable conditions. The open barrel, of either the tilting or midget type, is efficient when small lots are required in a limited time. An apparatus of simple design and with very few parts is the cheapest and most durable. The electric cleaner is perhaps

*Continued from page 462.

a greater aid to many than the plating machine. Its simplicity invites attention, its efficiency demands its adoption and its economy merits our admiration. It is truly a boon to the manufacturer. It is a labor-saver, requires no special equipment, can be operated by unskilled operator and used in various ways to effectively reduce the cost of the finished article.

In many shops where case-hardened steel parts are plated there is more or less annoyance from scale on portions which are not polished. A special solution and the electric current removes this scale, leaving the surface in good condition. The preparation of work for plating is only a matter of seconds when the cleaner is employed compared to the *soak and scour* method. Then after the plated articles leave the buffer they are smeared with Vienna lime and grease. Any plater knows how it bakes on and defies any mild method to remove it quickly by solution only. The electric cleaner does the trick in 30 seconds, the surface being as clean as when removed from the plating solution. The following instance will illustrate the comparison. Before using the electric cleaner in a certain shop two boys were employed to clean strips of nickel-plated steel after buffing, each boy being paid 15 cents per hour. The total number of pieces cleaned each day of 10 hours seldom exceeded 600 strips and four gallons of gasoline were used, this costing 25 cents per gallon. The total cost of labor and material equaled $4. An electric cleaner was constructed from an old discarded steel tank and one man at 25 cents per hour cleaned 5,000 strips in five hours. The total cost of labor and material (allowing ½ cent per 100 for depreciation of solution) equaled $1.50, the cost of the equipment being saved in less than five hours. This firm operates several tumbling barrels in the plating room and uses the soap skimmed from the surface of the cleaning solution as lubricating material in the various tumbling treatments, thus there is absolutely no waste. The solution used in the cleaner is composed of ½ pound whale oil soap, ½ gallon soda ash and 1 ounce sal-ammoniac per gallon of water. The strips are removed from the cleaner and plunged into boiling water, then hung up to dry. They are ready for wrapping in paper as soon as cool enough to handle. This process and solution does not require a reversal of the current. A direct current only being used, the articles being hung as cathodes.

All dips must be large enough to accommodate enough work to keep the platers uniformly engaged. Stripping solutions for the removal of old or defective deposits are money savers wherever properly installed. One firm which makes a specialty of refinishing old work estimates its savings for one year to be $3,000, the cost of solutions used was $40, an old plating tank and fittings having been employed.

Voltmeters and Ammeters

Voltmeters and ammeters are now universally recognized as absolutely essential. These should be tested at least twice each year. It is an excellent precaution to place all tanks upon either glass or porcelain insulators, thus preventing loss of current through small lines of crystalized salts and damp floors. We have seen large plants rendered almost useless through such leaks. The selection of anodes is a very important matter from the efficiency viewpoint. Inferior anodes thwart every effort toward the maintenance of an economic system in the plating room and fortunately for the manufacturers the progressive foremen of today are fast becoming enlightened upon the anode problem and the future will see less of the low percentage nickel anodes in use. Dense solutions, the *alpha and omega* of efficiency in nickel-plating, demand the best and purest anode that can be poured. This will naturally mean more than increased output as the deposited coating will be more effective as a protection to iron or steel.

All chemicals used in the various baths should be as pure as consistent reasoning will permit. There are exceptions to this rule, but it is poor policy to go too far in the use of commercial grades. A critical eye should observe all metallic salts received as these are the basis of the solutions and the *best* in some cases are quite ordinary.

All tanks heated by steam should be equipped with steam coils of ample capacity in order to raise the temperature of the solution quickly. The outlet pipe should be at least one size smaller than the inlet, with a valve so placed that it may be adjusted to permit the passage of a minimum amount of steam, thereby retaining the live steam sufficiently long to exhaust its heating capacity. This valve should never be molested when once set by the foreman. Water should be available to each heated tank so that a supply may be obtained without labor or delay. To make the steam and water delivery system efficient requires ample steam and water pressure in the mains. The plating room must have steam, water and power continually, or something must stop.

The drainage from the room is frequently an afterthought when planning an efficient department. A good drain is only required once in the history of the average shop and no makeshift substitutes should be tried. The health of the employes, the cleanliness of the department, the reliability of the various operations within the plating room depend largely on efficient drainage, whether the plant is located on the ground floor or the top flat.

The value of good ventilation is particularly noticeable in cases where plating rooms have moved from one location to another in the same factory and proper ventilating systems have been installed. The change improves the competency of the employes, labor is easier, output greater, dispositions are brightened, the men attend more diligently to allotted tasks and less cases of sickness are recorded. Good ventilation does not require a noticeable current of air moving through the room, but a change of air every three minutes will work wonders with men working over hot cyanide solutions. Special provisions are necessary to remove these poisonous fumes as they arise from the solutions. Hoods of various styles are easily made and placed above each tank and connected to a fan or natural draft effected by leading the pipe upward to the exterior of the building and surmounting the outer end with a rotating cowl or fan-like cap. The size and shape of such hoods depends on the class of goods being treated and whether the solutions are in constant use or only operated at regular intervals as would be the case where heavy deposits are produced, in which case a closed hood would be most effective. The plating room requires plenty of natural light. Basements are in no manner adapted to plating room purposes and should be avoided. Space forbids further reference to such quarters, but suffice it to say, plating is an art and as such should be kept on the higher levels. The artificial lighting should be the best obtainable and gas is so regarded. It gives a superior quality of light which is easy and agreeable to the eye. Its penetrating quality is strong; its high brilliancy is effective on all surfaces whether light, dark or semi-colored, while the modern gas mantle has an average burning hour record of from 800 to 1,500 hours. Statistics, however, show that there is at least 20 per cent depreciation in output under artificial light. No manufacturer can afford to disre-

gard an item of such importance. There are many other phases of plating room efficiency which could be dealt with, but those mentioned form a key to the whole. We desire to remind the manufacturer that in a great number of cases plating and polishing materials have merit from a working standpoint, but are absolutely without merit with regards to cost. Also the selection and purchase of stock for the manufactured article should be done by one conversant with the difficulties encountered in finishing inferior grades. This is particularly true with reference to sheet steel or steel and brass tubing. Harmony between the polishing and plating departments promotes efficiency in both, but if the stock is inferior, there is usually a tendency to blame the plater for poor finish. Thorough inspection of work is rarely practiced at present and the man behind the tank does not benefit by the omission. Analytical tests occasionally will prove very helpful to the plater in this regard, as he then is assured of the protection thus afforded and can state his case with a greater degree of certainty than would be possible if he depends on hydrometer test as used by many for metallic strength of solutions.

DIFFICULTIES OF THE PLATER

The Reason Why and the Remedy

Glue for Polishing Wheels

I have considerable trouble with my polishing wheels. The emery does not remain on the wheel long enough to finish a moderate size job. I believe poor glue is the cause, but as I am buying the best I can get, I concluded to seek your advice. Can you suggest anything which would increase the wearing qualities of the wheel when set up?

If you are using glue obtained in sheet form or large flakes, test it by bending. If it bends nearly to a circle before breaking and breaks with a clean, smooth surface at the fracture, the glue is probably of good quality for emery polishing. We do not advise the use of ground glue for setting up emery wheels. Soak the glue for 12 or 15 hours in cold water and dissolve in a glue pot, only enough for each day's requirements avoiding unnecessary heating. Then apply it to the wheels with a good brush. The wheels should be dry and warm. Roll the wheels in warm emery and dry in a closed box or cupboard heated by steam coils which may pass beneath the emery pans also. The heat should not be too great, but sufficient to dry the glue thoroughly before the wheels are used. In this manner you may increase the efficiency of your polishing wheels at least 50 per cent.

Satin Finish on Aluminum

We are manufacturing a line of aluminum hollow ware and would like to know how the satin finish on the inside of skillets is obtained.

The satin finish on the inside of skillets is obtained by acid dipping, or may be obtained by means of gentle spray of fine sand. The acid process, however, is in more general use as it is effective and rapid. The process consists of immersing the skillet in a warm solution of caustic soda. This solution immediately attacks the surface of the aluminum forming an oxide of aluminum. The skillets are then quickly rinsed in clean cold water and momentarily immersed in undiluted commercial nitric acid, which removes the oxide but does not attack the metal, the surface being left white and frosted. The frosting operation naturally acts on the outside of the utensil and if performed after polishing, ruins the finish. Therefore the article is frosted before polishing and care exercised in subsequent handling of the skillet. A method which is giving satisfaction is to frost the entire article as described above. Then polish and wash in a weak whale oil soap solution used warm and follow with a momentary immersion in a solution of undiluted nitric acid, specific gravity 1.34, 4 gallons and hydrofluoric acid specific gravity 1.157, ½ pint.

This produces a surface with a color approaching silver whiteness. The article is then rinsed and dried and the outside buffed without soiling the inside by handling. Wiping with warm clean cloths improves the luster. Much depends on the skill of the workman and the quality and class of goods, as to the choice of the two methods.

Probably a satisfactory finish can be obtained by using a steel brush and possibly this method is more economical than the one previously outlined. Polish the outside of the skillets in the usual manner and then brush the inside with a medium crimped steel wire brush of suitable size and containing a sufficient number of rows to be practical. Utensils having oval bottoms will require a cup-shaped brush. The finish of the article depends on the wire of the brush and the finer the wire the finer will be the finish. When doing this work it is essential that the wheel runs true. If the brush bumps, the wires will fly at that point. A coarse brush must not be revolved as fast as a fine one. Do not press the work hard against the wheel as the wire brush used with work held tightly against it can be revolved faster than if the work is pressed harder against the wheel. Large brushes cannot be revolved as rapidly as small ones. Coarse brushes require from 800 to 1,200 revolutions per minute, according to conditions. If the wires break off quickly in use, the usual cause is too high speed or the work is jammed against the brush or the brush bumps as a result of not running true. If the wires rust when not in use, lay the brush in a basin of weak lime water. The operation of frosting aluminum in this manner is accomplished with a dry brush and this point is essential in doing this work satisfactorily.

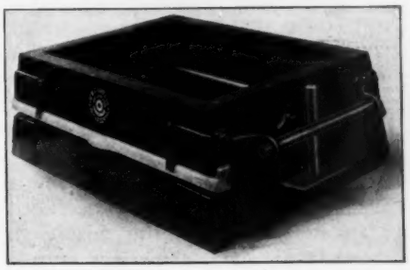
Cleveland Electroplaters Organize

At a meeting of platers employed in the shops of Cleveland and vicinity, held at the Cleveland Y. M. C. A., Saturday, Nov. 21, a local branch of the American Electroplaters' Society was organized and application will immediately be made for affiliation with this organization. W. D. Scott was elected temporary chairman and Chas. Werft, 403 Shaw avenue, Cleveland, was elected temporary secretary. H. J. Ter Dorst, of Akron, addressed the meeting and pointed out the benefits to be derived from affiliation with the American Electroplaters' Society. The meeting was well attended and at the next gathering, to be held at the Y. M. C. A., Dec. 5, officers will be elected.

Henry J. Weber has been elected secretary of the Wessling Bros. Foundry Co., Cincinnati.

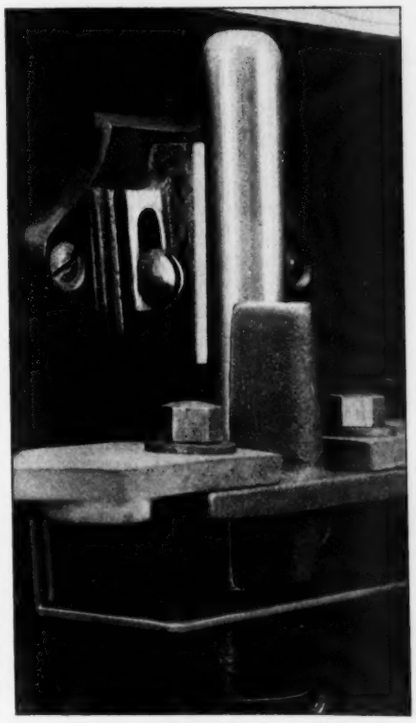
Andes Tapering Flask

A taper flask designed specially to meet the requirements of machine molding when using match plates or vibrator frames has been developed by E. B. Andes & Co., Lancaster, Pa. The principal features of the flask are shown in the accompanying illustrations. The walls are mahogany, 1⅛ inches thick and the sides and



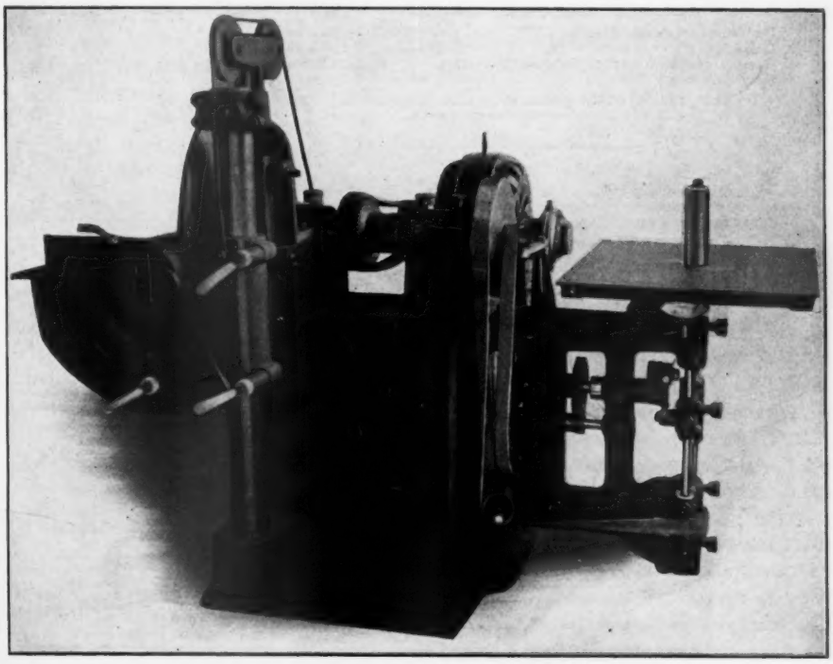
REINFORCED TAPER FLASK

ends are fitted together with a tongue and groove joints which serve to distribute the strain throughout the entire flask when it is in use. The corners and pin fittings are of gray iron of heavy section which adds to the rigidity of the construction. Wrought iron frames ⅛-inch in thickness are used to protect and reinforce the top and bottom of the cope and drag. Cast aluminum sand retaining strips are provided on the parting between



DETAIL OF FLASK PIN CONSTRUCTION

the cope and the drag. The pins are formed from ¾-inch cold rolled steel and are driven into their sockets. This permits their being changed without removing the pin sockets from the flask. The pin guides are brass and are located between the pins and the flask. They present long bearing surfaces and are provided with a wedge-like adjustment which, it is said, automatically centers the flask and eliminates the possibility of shifting. The location of the pin guides, it is claimed, not only protects them from being knocked out of adjustment accidentally, but also provides for the use of long pin guides with match plates. The bearings at the four corners of the flask are brass on steel and they may be removed at a minimum expense. The details of the flask may be modified to meet special requirements. The larger sizes for floor molding are fitted with roll-up hinges and loose cope bars.



COMBINATION GRINDER AND SANDER FOR PATTERN SHOPS

Combination Grinder and Sander

The accompanying illustration shows a motor-driven patternmakers' disc grinder manufactured by Charles H. Besley & Co., Chicago. The gear guards have been removed to show the construction. The disc wheel, which is steel, 30 inches in diameter and ¾-inch thick, runs at 750 revolutions per minute. The work table serving the disc wheel is 14 inches wide and 40 inches long. It may be tilted and locked at any angle from 75 to 135 degrees from the plane of the grinding disc, large, distinct graduations being provided to govern this adjustment. The construction is such that the inside of the working edge of the table remains within 1/32-inch of the disc, regardless of the angular adjustment, and the supporting mechanism is at the back of the disc wheel and below the face of the work table, so that the top of table is always clear of obstructions. The work table has a vertical adjustment of 25 inches, and is supported by a round, vertical shaft on which it may be swung away from the grinding disc for convenience in resetting wheel or facing off extra large patterns.

The machine is equipped with a sizing circle gage, for cylindrical and conical grinding, a sliding bevel gage, for simple and compound angle grinding, a sizing bevel gage, for simple and compound angle grinding to dimensions, and an angle plate for the free-hand cornering of thin work. The machine is driven by a three-horsepower Westinghouse induction motor which runs 1,140 revolutions per minute.

C. G. Smith Reads Paper

An interesting paper on the development of safety devices in connection with grinding and polishing machinery was read by Chas. G. Smith, of the Pittsburgh Emery Wheel Co., Pittsburgh, at the second annual Industrial Welfare and Efficiency Congress of the Department of Labor and Industry of the state of Pennsylvania, held at Harrisburg, Nov. 17. Mr. Smith's paper covers the development of safety devices in connection with grinding wheels from a historical standpoint and shows how safeguards have increased efficiency.

THE FOUNDRY

A monthly journal devoted to all branches of the foundry trade.

Published by

The Penton Publishing Co.

Penton Building, CLEVELAND

BRANCH OFFICES

BIRMINGHAM, ENG. - - - Prince's Chambers
CHICAGO - - - - 1521 Lytton Bldg.
CINCINNATI - - - 503 Mercantile Library Bldg.
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PITTSBURGH - - - 2148-49 Oliver Bldg.
WASHINGTON, D. C. - - - 206 Corcoran Bldg.

SUBSCRIPTION

United States and Mexico - - - - $1.00 a year
Canada - - - - - - $1.50 a year
Great Britain and other Foreign Countries Eight Shillings
Single Copies - - - - - - 15 cents

Copies published three months or more previous to date of current issue, 25 cents each.

ADVERTISING

All communications relating to advertising copy, discontinuances, etc., must be received on the 10th of the month preceding date of publication.

ENTERED AT THE POST OFFICE AT CLEVELAND AS SECOND CLASS MATTER

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Contents

TEST ON MELTING SHOT IRON IN THE CUPOLA 467
ST. LOUIS FOUNDRYMEN'S CLUB 468
TITANIUM STEEL CONVERTER TOPS 468
A WATER-PROOFING MATERIAL 468
FOUNDRY CUPOLA OF NEW AND INTERESTING DESIGN 469
NOTES ON GALVANIZING MALLEABLE CASTINGS 470
HOW RADIATOR CORES ARE MADE EFFICIENTLY 471
RESEARCHES IN ANNEALING MALLEABLE CASTINGS 474
OPERATING A FOUNDRY ON A SCIENTIFIC BASIS 479
THE 1915 FOUNDRYMEN'S MEETING 486
COST AND EFFICIENCY SYSTEM 486
DEVELOPMENTS IN ELECTRIC BRASS FURNACE MELTING 487
MANGANESE FLOUR AS SURFACE HARDENER 490
THE PHILOSOPHY AND PROPERTIES OF ALLOYS 491
PISTON RING MIXTURE 495
BRASS MIXTURE 495
MIXTURE FOR STREET RAILWAY BRASSES 496
REMOVING IRON FROM BRASS 496
MIXTURES FOR BUILDERS' HARDWARE 496
ACID-PROOF BRONZES 496
BEARINGS FOR MACHINE TOOL SPINDLES 496
SOLDERING WHITE METAL 496
TROLLEY WHEEL MIXTURE 496
PROTECTIVE COATINGS FOR IRON AND STEEL 497
RESULTS ACCOMPLISHED BY SCIENTIFIC MANAGEMENT—II 498
GLUE FOR POLISHING WHEELS 500
SATIN FINISH ON ALUMINUM 500
CLEVELAND ELECTROPLATERS ORGANIZE 500
ANDES TAPERING FLASK 501
COMBINATION SANDER AND GRINDER 501
TRADE OUTLOOK 502
BOOM TIMES 502
SAFETY REGULATIONS 503
GENERAL INDUSTRIAL NOTES 504
NEW TRADE PUBLICATIONS 504

Trade Outlook

NOVEMBER witnessed the breakup of the deadlock on pig iron which had existed practically since the commencement of the war in Europe. Reassured by the results of the congressional elections, the liquidation of our foreign trade balance through heavy exports and the substantial increase in bank reserves throughout the country, many foundrymen decided that the opportune moment for making purchases had arrived. Although the buying movement thus initiated has not yet assumed large proportions, there is considerable evidence on every hand that the corner has been turned. The foundry industry as a whole still is operating at less than half of its normal capacity, but encouragement is found in the fact that many shops booked substantial tonnages during the month just closed. The pig iron buying movement, therefore, has not been based wholly on the expectation of future business. Some of it is the result of orders for castings already in hand. Sellers of pig iron in the Buffalo district have been agreeably surprised by the amount of business they have been able to obtain in the face of prevailing industrial conditions. Prices in the leading centers are now on a more attractive basis than at any time for the past two years. Foundry grades are quoted as follows: No. 2 Chicago, $13; Buffalo, $12 to $12.25; Philadelphia, $14.25 to $14.50; Pittsburgh, $13.70 to $13.95; Cleveland, $13.25 to $13.50; Birmingham, $10, and Ironton, $13. Malleable is quoted $13, Chicago, and $12, Buffalo, while basic is being sold at $13.45 to $13.60, Pittsburgh, and $14 in eastern Pennsylvania.

Boom Times

HOPE springs eternal" is an old saw which can be applied to present trade conditions and to the optimists and their superabundance of hope must be traced the world's greatest developments. Hope occasionally becomes prophetic and inspires men with that feeling of optimism which turns night into day and impels them to take a peek at the bright lining of the proverbial cloud. There is no greater optimist than David McLain, Milwaukee, who believed not so many years ago that it was possible to help foundrymen to improve their practice by instructing them by mail. Some time ago Mr. McLain went on record and predicted a quick return of prosperity. But for the intervention of the European war there is little doubt but that trade activity would have returned as predicted by him. Notwithstanding the unforeseen turn of affairs Mr. McLain has lost none of his optimism as indicated by the following:

> If you will refer to my advertisement on page 40 of the August issue of THE FOUNDRY you no doubt will be surprised to learn that I predicted boom times in 90 days, and I believe I can hear you say "Bunk", or "Mack over-reached himself this time". The copy for this advertisement was furnished you on July 10, and represented the results of a careful survey of conditions as reported to this office from many different sections of the United States and Canada and there was no stopping the boom under ordinary conditions, but you know "man proposes

and the Kaiser disposes".

Naturally, after going on record through the advertising columns of your paper I kept close tab on the market and war reports through the month of August and believed that September would open up fairly active and close good and strong.

Beaten again! But by whom? Not the Kaiser this time, but by the business men in general, who had simply quit giving orders as soon as the war started and, of course, if no orders are going out, very little business is being done.

I feel that the war is going to be a long, drawn-out affair, because even if the Allies do drive the Kaiser back into Germany, how are they going to lick him there? As soon as the Mohammedans get started, I am going to quit reading the daily papers and devote all of my time to my own business. This is my fourth experience with the trade depression and can recall that of '73, '93 and '07.

During a recent business trip through Ohio I met foundry owners, purchasing agents and other officials who act as if there was never going to be any more business, and one foundryman whose volume of business aggregates over $100,000 a year, told me he would not even order a new suit. They all were unanimous in declaring that they certainly would not give an order for anything nor would they pay out money on any new investment.

One of these men had lost more than $75 worth of castings on the last heat before my arrival, but still he would not pay $75 to prevent this loss from occurring again. Incidentally, I might mention that since my visit his plant has been closed down entirely, not a man being employed in the shop. The foregoing is merely cited to pave the way for the following:

If the war lasts forever—or if the railroad companies cannot get their hundred million increase—or if business men generally are going to drift along until the sheriff gets them, I believe that if the small and medium business men of the United States will devote all of their energies to their business, they soon will have no need to fear what the big fellows are doing, as they themselves have it in their power to say whether or not we shall have good or bad times. I firmly believe that if every firm requiring equipment or material would place this order now, the wheels of industry again would begin to turn at a merry pace. During my travels I continually get in touch with men who have money invested in business, but who really know little or nothing about the foundry industry and I can readily appreciate why it is that practically 25 per cent of the foundries either changed hands or were sold out during the period of 1912 to 1914, as stated in an article published in THE FOUNDRY some time ago. Poor trade did not cause all of these failures, as the great commercial agencies in their reports of failures in all lines of business, including foundries, show that the percentage due to lack of knowledge of the business in which these firms are engaged is from two to four times greater than that of all other reasons combined, not even excepting lack of capital. These are not estimates, not guesses, but the testimony of actual figures. It points to one great principle, namely, that knowledge is a bigger asset than money.

But foundry history shows that there have been more dollars and cents than common sense invested in the business. The idea that a little sand and a little melted iron will make a casting must pass. Poor trade did not cause failures in one out of every four foundries. Prices were as high as ever and wages did not materially increase. No, the profit that was added to the job in the office was lost when the castings reached the shipping room.

Why? That's the puzzle, and the answer is locked up in things that cannot be seen in the foundry. A man may have eyes, ears and hands, but unless he adds to these trained brains, he never can be a success in the foundry game.

The foregoing communication not alone breathes optimism, but points the way to greater success in the foundry industry. Lack of knowledge and experience is the roughest road that many foundrymen are compelled to travel today and those who are equipped not alone with machinery, but with brains, will emerge from the present lull in activity to successes which they never believed would possibly crown their efforts.

Safety Regulations

A SIGNIFICANT feature of the recent second annual industrial welfare and efficiency congress, held at Harrisburg, under the auspices of the Pennsylvania bureau of labor and industry, was a proposal to draw up a set of rigid safety regulations for blast furnaces. It was suggested by F. H. Willcox, of the United States Bureau of Mines, that these regulations should aim to cover features of construction, operation and practice in a detailed and explicit manner and to include every practical safeguard and method that can be reasonably insisted upon. It is only a short step from regulations for blast furnaces to regulations regarding the construction and operation of foundry cupolas, air furnaces, etc. It is believed that laws of this sort enacted by state legislatures would be extremely distasteful to foundrymen. Nevertheless, the tendency toward state paternalism must be recognized and the best way to combat it is to so thoroughly surround all foundry operations with safeguards that accidents will be so few as to make the necessity for any regulations appear ridiculous.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The Union Pacific railroad contemplates the erection of a foundry in Ogden, Utah.

Johnson Bros., North Chicago, Ill., are constructing a brass foundry and pattern shop.

The Standard Foundry Co., Worcester, Mass., is erecting a one-story addition, 34 x 80 feet.

The Weir Stove Co., Taunton, Mass., is erecting an addition to its foundry and pattern shop.

The Waynesboro Iron Works, Waynesboro, Pa., will erect a two-story foundry costing $60,000.

The W. A. Heath Machine Works, Lestershire, N. Y., is erecting an addition to its foundry.

The Waltham Foundry Co., Waltham, Mass., has been incorporated with $48,000 capital by Anthony A. Curtin and Thomas I. Curtin.

The Jewell Steel & Malleable Co., Buffalo, contemplates the erection of a brick and concrete core room, 60 x 140 feet.

Frank M. Mackin & Co., Baltimore, Md., will erect a 45 x 75.6-foot foundry at a cost of $3,000.

The Crescent Brass Works, Reading, Pa., will erect a one-story, 24 x 30-foot aluminum foundry.

The Beecher-Fowler Mfg. Co., Louisville, Ky., has taken over the Arthur Jones Foundry Co. and will enlarge its business.

The Berkely-Fourness Co., recently organized at Madison, Wis., has established a plant for the production of die castings.

The Androscoggin Foundry Co., Auburn, Me., will erect a foundry to cost $50,000. George W. McFadden is proprietor.

The Werner & Pfleiderer Co., Saginaw, Mich., will erect a foundry at a cost of approximately $45,000.

The Alma Standard Foundry & Mfg. Co., Alma, Mich., will erect additions to its plant for the manufacture of furnaces.

The Concord Foundry & Machine Co., Concord, N. C., is enlarging its plant and installing new machinery.

The Modern Foundry Co., Cleveland, will erect an addition to its foundry at 2088 Scranton road at a cost of $5,000.

Contracts have been awarded for the erection of a foundry for the John M. Fay Foundry Co., St. Joseph, Mich.

The Chicago Bearing Metal Co., brass founder, Chicago, will erect a one-story brick addition to its plant at 2234 West Forty-third street which will cost $4,000.

The Hench & Dromgold Co., agricultural implement manufacturer, York, Pa., will construct a two-story, 80 x 160 and an 80 x 240-foot addition.

The Jellico Foundry Co., Jellico, Tenn., has been incorporated with $10,000 capital by P. L. Johnson, J. T. Moore, G. A. Russell, W. G. Smith and John E. Brown.

The name of the Star Foundry Co., St. Louis, has been changed to the Thomas Furnace Co. The company will purchase new equipment for the manufacture of furnaces.

The Acme Metal Co., Chicago, will remodel and equip the old Ft. Madison foundry buildings, Ft. Madison, Ia., and will engage in the manufacture of non-ferrous metal alloys. The company's plant at Chicago is to be abandoned.

The Engineering Supply Co., San Francisco, has taken over the old plant of the Brisco Iron Works, Lindsay, Cal. New equipment will be added and the company will engage in a foundry and general machine business.

The Well Tool & Iron Works, Ltd., Calgary, Alberta, Can., has been incorporated with $20,000 capital to engage in the manufacture of tools, etc., and to operate an iron foundry.

The Rochester Monitor Co., Rochester, has been incorporated with $30,000 capital to engage in a machine shop and foundry business. The incorporators are S. A. Thomas, B. D. Straight and J. S. Avery.

Contract has been awarded for the erection of an addition to the foundry of the Cleveland Welding & Mfg. Co., 2133 West 117th street, Cleveland, which will cost approximately $10,000.

The Woodstock Foundry, Ltd., Woodstock, N. B., Can., has been incorporated with a capital stock of $40,000 to take over the foundry formerly owned by Connell Bros., Ltd. The incorporators are W. Gibson, William S. Skillen and W. S. Sutton.

The Darling Pump & Mfg. Co., Williamsport, Pa., is erecting a new plant of steel concrete construction, 120 x 200 feet. The roof will be of the saw-tooth type and the shop will be divided by three bays, each commanded by an electric traveling crane. The old gray iron foundry will be remodeled and will be equipped for the manufacture of brass castings.

The Hammond Malleable Iron Co., Hammond, Ind., recently incorporated with $75,000 capital, has broken ground for a foundry, 70 x 340 feet, and an annealing building, 80 x 160 feet. The first equipment to be installed will consist of a 20-ton furnace and four ovens in the foundry. The company will manufacture automobile and agricultural implement castings. Henry Wanner, 180 North Dearborn street, Chicago, is president.

NEW TRADE PUBLICATIONS

PATTERN WAX.—The United Compound Co., Buffalo, N. Y., has issued literature covering a new line of pattern wax which it has placed on the market. This wax is made in two grades, soft and hard. The soft wax is about the same consistency as bees wax and may be used for the same purposes. The hard wax is said to have exceptional wear resisting qualities and is designed particularly for filling in defects either in wood or metal patterns. Either grade will melt at about 150 degrees Fahr.

WOODWORKING TOOLS.—An attractive 10-page bulletin, describing various classes of pattern shop machinery has been issued by the Bridgeport Engineering Co., Bridgeport, Conn. Considerable space is given to illustrations, descriptions and specifications of sanding machines, both single and double disc, with and without vertical drums. Trimmers, mitre boxes, saw tables, clamps, etc., also are described and illustrated.

FUEL OIL ENGINES—Bulletin No. 34-W issued by the Chicago Pneumatic Tool Co., Chicago, under a recent date, describes and illustrates a number of different sizes of fuel-oil gas engines which are manufactured by this concern. These engines are especially suitable for operating air compressors, etc., in foundries and machine shops where a great amount of power is not needed and where electrical energy is expensive. The engines are built in a range of sizes from 12 to 45 brake horse-power.

MONORAIL CRANES.—An exceedingly well illustrated catalog devoted to electric monorail cranes, has been issued by the Sprague Electric Works of the General Electric Co., West Thirty-fourth street, New York City. These cranes are adapted for a variety of uses in handling material in industrial plants and are particularly applicable to foundry operations. Another catalog recently issued is devoted to dynamometers for measuring horsepower, generated or absorbed. It can be used for testing gasoline engines, carburetors, magnetos, belts, transmissions, etc.

KEROSENE TORCHES.—The Hauck Mfg. Co., Brooklyn, N. Y., is sending to the trade a folder describing its kerosene torch, which can be used in foundry operations for drying cores and for miscellaneous heating purposes for which a portable hand tool can be applied. The torch uses kerosene instead of gasoline for fuel and it is claimed that the temperature of the flame is 300 degrees Fahr.

POLISHING AND BUFFING MACHINERY.—A recent catalog issued by the Webster & Perks Tool Co., Springfield, O., is devoted to its line of polishing and buffing machinery, including electric-driven, floor-type polishing and buffing lathes, self-oiling grinding and polishing machines, three-quarter grinder, electrically-driven, floor-type grinder, ball bearing polishing and buffing lathe, etc.

IRON CEMENT.—The two grades of iron cement manufactured by the Smooth-On Mfg. Co., Jersey City, N. J., are described briefly in a four-page booklet recently issued by this company. Grade "A" is especially recommended for high-grade castings that are to be highly finished or machined. The cement so amalgamates with the casting that it is claimed it is practically impossible to detect it. It expands and contracts in the same ratio as the body of the casting and, therefore, cannot fall out. Grade "B" is a slightly cheaper cement and is recommended for repairing defects in castings of a minor character. However, this grade possesses all of the desirable features of grade "A" and is recommended for work not quite so particular as that for which grade "A" is to be used.

Index to Volume XLII

January---December, 1914

A

Accidents, How to Prevent Pattern Shop. 189
Acid-Proof Bronze 496
Acid-Resisting Bronze 194
Acid-Resisting Iron 116
Acid-Resisting Metal 311
Adjustable Aluminum Snap Flask..... 323
Adjustable and Interchangeable Snap Flask. 159
Adjustable Flask Clamp..... 245
Adjustable Hood for Grinding Wheels... 121
Adjustable Mold Jackets for Foundry Use. 377
Air, Volume of, Required for Melting.... 128
All Eyes Are Now Turned Toward Chicago 327
All-Steel Foundry Riddle..... 82
Alloy for Machine Screws..... 457
Alloy, Hard Copper 6
Alloy, Lead 55
Alloy, Low Specific Gravity..... 73
Alloy, Malleable Zinc..... 60
Alloy, Manfecual—A New..... 299
Alloy, New Copper..... 75
Alloy, Strengthening No. 12 Aluminum... 74
Alloying Zinc and Lead..... 16
Alloys, Copper, Approximate Melting Points of 69
Alloys, Copper, Electric Furnace for..... 77
Alloys, Metals and, Used for Die Castings 19
Alloys, Nickel 144
Alloys, Progress in Nomenclature of..... 413
Alloys, Sulphur in 74
Aluminum, A Hot Shortness Testing Machine for 412
Aluminum Alloy, No. 12, Strengthening.. 74
Aluminum, Brazing 23
Aluminum Bronze, Boron in..... 97
Aluminum Castings, Polishing..... 302
Aluminum Castings, Suggestions for Making 67
Aluminum, Coloring 361
Aluminum Core Mixture..... 23
Aluminum Crank Case Difficulties..... 22
Aluminum Crank Case, Large..... 262
Aluminum Die Castings..... 455
Aluminum Match-Plate Mixture..... 223
Aluminum Melting Difficulties..... 73
Aluminum Plates, Wavy Surface on..... 108
Aluminum, Record-Breaking Production of 417
Aluminum Rolls 311
Aluminum, Satin Finish on..... 500
Aluminum Scrap, Difficulties from Use of 144
Aluminum Shrinkage 23
Aluminum Solder 108, 223
Aluminum Solder, How to Use..... 193
American Electro-Platers' Society, Convention of 274
American Foundrymen's Association, Dr. Moldenke Resigns Secretaryship of..... 79
American Foundrymen's Association, Meeting of Officers..... 195
American Foundrymen's Association Meeting, Papers for, and the Exhibitors..... 315
American Foundrymen's Association, Program 329
American Foundrymen's Association, Report of Annual Meeting of, in Chicago. 385
American Foundrymen's Association, Standard Ladle Nozzles for Steel Foundries. 402
American Implement Co., An All-Steel Foundry Riddle 82
American Institute of Metals Has Successful Meeting 409
American Institute of Metals, Program... 331
American Institute of Metals, Transactions 311
American Sand Blast & Machinery Co., Sand Blast Barrel..... 427
American Society for Testing Materials, International Specifications for Cast Iron 317
American Society for Testing Materials, Standard Specifications for Locomotive Cylinders, Data Sheets Nos. 167 and 168, August, 1914.
Analysis, Why the..... 440
Andes, E. B., & Co., Rig for Molding Sanitary Ware 381
Andes, E. B., & Co., Taper Flask..... 501
Anneal Gray Iron, How to, to Obtain Best Results 263
Annealing, Loss of Weight from..... 226
Annealing Malleable Iron, Loss of Weight in 452
Anode Mixtures 58
Anti-Acid Chains, Cast..... 116
Application of Electricity to Foundry Work 29
Approximate Melting Points of Copper Alloys 69
Arcade Mfg. Co., A New Roll-Over Core Machine 81
Arcade Mfg. Co., A Stationary Head Squeezer 80
Arcade Spring Sprue 201
Associated Foundry Foremen, Offers Course to, in Membership Contest..... 93
Automobile Gear Cases, Rig for Molding. 196
Automobile Radiator Cap, Enamel for.... 58

B

Basic Mineral Co.'s Fluxes..... 159
Ball-Bearing Grinding Machine..... 283
Barlow Foundry Co., The Old Boyden Foundry Passes Into History..... 247
Bearing Metal for Machine Tool Spindles. 496
Bennett-O'Connell Co., Mechanical Plating Barrel 37
Benson Bros., Ltd., Pipe Plant for Australia 316
Besley, Chas. H., & Co., Grinder and Sander 501
Betts & Elliott, Rig for Molding Automobile Gear Cases..... 196
Betts & Elliott, Will Make Foundry Rigs. 168
Bleichert, Adolph, & Co., Telpher Systems Applied to Foundry Operations..... 41
Blistering of Nickel Plate..... 149
Bloomsbury Graphite Co..... 161
Board Feet in Pattern Lumber, ...
..Data Sheets Nos. 159 and 160, April
Board Feet in Pattern Lumber.....
..Data Sheets Nos. 161 and 162, May
Boiler Bases, Molding, by a New Method 53
Boiler Sections, Making, on Molding Machines 429
Bonus Work, Task and..... 280
Bonvillain, Ph., & E. Ronceray, Twin-Table Molding Machine 199
Boron in Aluminum Bronze..... 97
Bouillon, C., Vertical Draw Molding Machine 241
Boyden Foundry, Old, Passes Into History 247
Brass Bearing Mixture..... 73
Brass Casting Mixtures..... 458
Brass Castings, Color of..... 23
Brass Castings, Cores for..... 309
Brass Castings, Dip for..... 115
Brass Castings, White Spots on..... 458
Brass, Finishes for 233
Brass Foundry of the Future..... 71
Brass Foundry, Operating a, Under Difficulties 361
Brass Foundry, Safety and Sanitation in the 394
Brass Foundry Sand..... 272
Brass Furnace, Electric..... 487
Brass Mixture 495
Brass Mixture, Hard..... 414
Brass, Removing, from Iron..... 496
Brass Sleeves, Porous..... 107
Brass Valve Troubles..... 23
Brass, Yellow and Red, Mixtures..... 310
Brasses, Driving, Mixture for..... 194
Brasses, Mill 144
Brasses, Rolling Mill, Mixture for..... 273
Brazing Aluminum 23
Brazing Material, New..... 316
Brillion Iron Works, Pouring Molds by an Ingenious Method 123
British Foundrymen Meet at Leicester... 236
Bronze, Acid-Proof 496
Bronze, Acid-Resisting 194
Bronze, Aluminum, Boron in..... 97
Bronze Castings, Spongy, Causes of..... 310
Bronze, Drop-Pouring Process of Casting.. 415
Bronze, Effect of Heating on the Properties of 453
Bronze, Manganese, Tough..... 74
Bronze Melting, in a Cupola..... 144
Bronze, Melting, in a Cupola..... 193
Bronze Mixture, Hydraulic 143
Bronze Mixtures, Strong..... 457
Bronze, Nickel, Mixtures..... 273
Bronze, Overcoming Shrinkage in..... 223
Bronze, Phosphor, Cheap..... 108
Bronze, Phosphor, Difficulties..... 108
Bronze, Reducing Casting Cost of Ornamental 135
Bronze Valves, Manufacture of..... 21
Bronze, Victor 60
Builders' Hardware, Mixtures for..... 496
Building a New Foundry Over Operating Shop 227
Burning Gray Iron Onto Steel..... 157
Burning-On, Repairing Broken Gear by... 117

BOOK REVIEWS:

Foundry Machinery 10
Investigating an Industry..... 52
Investigation of the Physical Properties of Cast Iron 66
Patternmaking 10
The Efficient Man 201
The Steel Foundry 201

C

Calculating Mixtures for Malleable Iron... 39
Canadian Hanson & Van Winkle Co., Experimental Plating Plant..... 275
Car Wheel Mixtures 336
Car Wheels, Chilled Cast Iron, Mixtures for 312
Car Wheels, Mine, Cracking of..... 319
Carborundum, Describes Manufacture of. 68
Carburetor Castings, Mixture for..... 194
Carburetor Mixture 224
Carlin Clamp Co., Adjustable Flask Clamp. 245
Carter Metals Cleaning Co., Evans High Pressure Sand Blast..... 160
Cartridge Cases, Difficulties in Making.... 310
Case, J. I., Threshing Machine Co., Special Core Ovens for Case Plant..... 295
Cast Anti-Acid Chains..... 116
Cast Iron, Manganese in..... 147
Cast Iron Car Wheels, Chilled, Mixtures for 312
Cast Iron, Expansion of..... 177
Cast Iron of Unusually Interesting Structure 404
Cast Iron, International Specifications for. 317
Cast Iron Pipe Specifications, International Association for Testing Materials..... 317
Cast Iron Stove Plate, Early Manufacture of 216
Cast Iron Test Bar Proposal, International Association for Testing Materials..... 319
Casting Bronze, Drop-Pouring Process of. 415
Casting, Modern Pipe..... 292
Casting Phosphor Bronze Liners Onto Steel 107
Casting Steel Spokes Into Hubs..... 292
Castings, Aluminum, Suggestions for Making 67
Castings, Brass, Color of..... 23
Castings, Brass, Cores for..... 309
Castings, Brass, Dip for..... 115
Castings, Carburetor, Mixture for..... 194
Castings, Formulas for Finding the Weights of
..Data Sheets Nos. 155 and 156, Feb.
Castings, Formulas for Finding the Weights of
..Data Sheets Nos. 163 and 164, June
Castings, Formulas for Finding the Weights of
..Data Sheets Nos. 169 and 170, Sept.
Castings, Formulas for Finding the Weights of.....
..Data Sheets Nos. 171 and 172, Oct.
Castings, Formulas for Finding the Weights of
..Data Sheets Nos. 173 and 174, Nov.
Castings, Formulas for Finding the Weights of
..Data Sheets Nos. 175 and 176, Dec.
Castings, Hard 440
Castings, Hard and Soft 262
Castings, How Manganese Steel, Are Made 132
Castings, How to Estimate Selling Prices of 449
Castings, Iron, Perimeter of Girth Table for Determining the Weight of.....
.....Data Sheets No. 165, July
Castings, Lacquering Small..... 149
Castings, Large Manganese Bronze..... 157
Castings, Matching Color of..... 193
Castings, Misrun 74
Castings, Ornamental 273
Castings, Plain Talk About Selling..... 242
Castings Plant, New, in the Automobile City 175
Castings, Polishing Aluminum..... 302
Castings, Scabbing and Rat Rails on..... 52
Castings, Solid 354
Castings, Spongy Bronze, Causes of..... 310
Castings, Table for Finding Weights of .....Data Sheet No. 166, July
Cause of Spotted Finishes..... 234
Causes of Spongy Bronze Castings..... 310
Chains, Cast Anti-Acid..... 116
Changing the Composition of Malleable Iron 6
Charge for a 28-Inch Cupola..... 452
Charging Platform, Inclined Elevator to. 283
Chemical Changes of Malleable Iron..... 146
Chicago Foundrymen's Club..... 39
Chicago Foundrymen's Club Meeting,..68, 121
Chicago Foundrymen Plan for Convention 79

Chilled Iron Difficulties..... 147
Chilling, To Prevent Iron..... 408
Clamp, Adjustable Flask..... 245
Cleaning Room, Large, Dust Collector for. 306
Coatings, Protective, for Iron..... 497
Coke for Crucible Melting..... 194
Coke Recovered from the Cupola Dump... 447
Coleman Foundry Equipment Co..... 295
Color of Brass Castings..... 23
Color, Matching, of Castings..... 193
Coloring Aluminum..... 361
Colors of Lenses for Protective Goggles and Masks 282
Columbia Steel Co., A New Departure in Steel Foundry Practice..... 75
Combination Spray Can and Mold Dryer.. 199
Composition, New Pattern Plate..... 47
Composition, Match-Plate..... 310
Compound, Permanent Mold..... 264
Compressed Air as an Aid to Foundry Efficiency 337
Compressor, Air, Oil Engine-Driven..... 244
Continuous Brake Shoe Foundry..... 11
Convention of American Electro-Platers' Society 274
Converter Tops, Titanium Steel..... 468
Converter, Wonderful Tropenas, Heat Record 235
Converters, Side-Blow, Ganister Lining in. 441
Conveyor Screw, Plaster Pattern for a.... 156
Copper Alloy, Hard..... 6
Copper Alloy, New..... 75
Copper Alloys, Approximate Melting Points of 69
Copper Alloys, Electric Furnace for..... 77
Copper and Lead, Equal Parts of..... 194
Copper-Plating Galvanized Iron..... 115
Copper, Scrap, Use of..... 414
Core Box, Making Pipe Pattern and, in Plaster 296
Core Machine, A New Roll-Over..... 81
Core Mixture, Aluminum..... 23
Core Mixture for Phosphor Bronze..... 224
Core Ovens, Special, for Case Plant..... 295
Core Sand, Providence..... 436
Cores for Brass Castings..... 309
Cores in Multiple, A New Machine for Making 425
Cores, Radiator, How Made Efficiently.... 471
Cracking of Mine Car Wheels..... 319
Crank Case, A Large Aluminum..... 262
Crank Case Difficulties, Aluminum..... 22
Crucible of New Design..... 160
Crucible Melting, Coke for..... 194
Crucible Tongs 462
Crucibles, The Use and Care of..... 307
Cupola Bed, Height of a..... 55
Cupola Bridging Problem.....162, 268
Cupola Bridging, Another View on..... 268
Cupola, Charge for a 28-Inch..... 452
Cupola Charging Machine, How to Operate a 151
Cupola Dump, Coke Recovered from the.. 447
Cupola Explosions, A Device for Preventing 267
Cupola, How to Daub the..... 150
Cupola Lining, Life of..... 342
Cupola, Melting Bronze in a..... 193
Cupola Melting Difficulties, Too Much Coke on the Bed 162, 306
Cupola Melting, Slow..... 214
Cupola, New Design of..... 469
Cupola Process, Pneumatic..... 146
Cupola, Proportions of a..... 257
Cupola, Rebuilding an Old..... 10
Cupola, Remodeling an Old..... 408
Cupola, Test of Melting Shot Iron in..... 467
Cupola, The Design and the Operation of the 252
Cupola, Tuyere Area of the..... 418
Cupola Tuyeres, Distance, of, from Sand Bottom 418
Curtis Pneumatic Machinery Co., Sand-Handling Apparatus 279
Cutler-Hammer Mfg. Co., Handling Steel Castings With a Lifting Magnet..... 276
Current Foundry Inefficiencies and Practices 344
Cutting Gagger Costs 214
Cutting the Cost of Molding Sheave Wheels 287

D

Danville Malleable Iron Co., Making Malleables Under Modern Conditions..... 85
Describes Manufacture of Carborundum.. 68
Design and the Operation of the Cupola... 252
Detroit Foundrymen's Association..... 209
Detroit Foundrymen's Association Meeting 67
Detroit Hoist & Machine Co., Portable Geared Electric Hoist..... 120
Detroit Steel Casting Co., New Castings Plant in the Automobile City..... 175
Development of Match-Plate Molding..... 213
Device for Preventing Cupola Explosions. 267
Die Castings, Aluminum..... 455
Die Castings, Electro-Plating Zinc Alloy.. 232
Die Castings, Metal and Alloys Used for. 19
Difficulties Due to Oxidation..... 458
Difficulties from Use of Aluminum Scrap. 144
Difficulties in Making Cartridge Cases.... 310
Difficulties, Side Lights on the Foundryman's 127
Dip for Brass Castings..... 115
Discussion of Rapid Nickel Solutions..... 300
Distance of Tuyeres from Sand Bottom... 418
Dixon, Joseph, Crucible Co., A Crucible of New Design..... 160
Draft, Forced or Natural..... 458
Drop-Pouring Process of Casting Bronze.. 415
Dry Sand Blower Casing Mold..... 133
Durable Plating Deposits..... 35
Dust Collector for Large Cleaning Room.. 306

E

Early Manufacture of Cast Iron Stove Plate 216
Economies in the Manipulation of Sand.. 197
Economy in Production of Miscellaneous Work 298
Effect of Heating on the Properties of Bronze 453
Effects of Vanadium on Properties of Pig Iron 303
Efficiency in the Plating Room..... 57
Electric-Arc Welding and Foundry Efficiency 336
Electric Brass Melting Furnace..... 487
Electric Furnace and Method of Operation 17
Electric Furnace for Copper Alloys..... 77
Electric Furnace, Tropenas Converter Versus 180
Electric Vibrator 285
Electrically-Driven Grinder 159
Electricity, Application of, to Foundry Works 29
Electro-Plating Zinc Alloy Die Castings.. 232
Electro-Silvering Porcelain 150
Elevated Crucible Furnace..... 465
Elevator, Inclined, to Charging Platform.. 283
Elimination of Dissolved Silica..... 457
Elliott, H. A., Hardness Testing Machine. 161
Enamel for Automobile Radiator Cap..... 58
Enameling Cast Iron and Steel, The Art of 7
Equal Parts of Copper and Lead..... 194
Evans High Pressure Sand Blast..... 160
Exeter Machine Works, Large Manganese Bronze Castings 157
Exeter Machine Works, Molding and Casting Large Bronze Valve Parts..... 205
Exhibition of Foundry Equipment and Supplies 332
Expansion and Shrinkage..... 82
Expansion of Cast Iron..... 177
Experimental Plating Plant..... 275
Explosions, Cupola, A Device for Preventing 267
Eye Protectors, Improved..... 37

EDITORIALS:
Alloy Nomenclature 158
Boom Times 503
Brass Foundry Losses..... 320
Crucible Steel Casting Industry..... 321
Foundry Accidents 240
Foundry Iron Production..... 321
Foundry Trade in Retrospect..... 36
Molding Machine Auxiliaries..... 198
Oil Your Molding Machines..... 278
Pig Iron Output in 1913..... 118
Safety Regulations 502
Steel Casting Production..... 321
The Chicago Convention..... 376
Trade Outlook 78, 118, 158, 198, 240, 278, 321, 376, 424, 464, 502
What the Convention Taught..... 424

F

Facilitating the Handling of "Express" Orders 148
Facing Mixture, Silica..... 146
Fan, An Unusual Forge..... 442
Federal Foundry Supply Co., Adjustable Aluminum Snap Flask..... 323
Federal Foundry Supply Co., Adjustable and Interchangeable Snap Flask..... 159
Federal Foundry Supply Co., New Iron Flask for Brass Foundries..... 119
Finishes for Brass 233
Finishes, Spotted, Cause of..... 234
Fire Prevention, Lesson in..... 316
Fitting Patterns 266
Flask, Adjustable Aluminum Snap..... 323
Flask, Adjustable and Interchangeable Snap 159
Flask Clamp, Adjustable..... 245
Flask, New Iron, for Brass Foundries.... 119
Flask Parts, Molding Cast Iron..... 442
Flask, Taper 501
Flasks, Heavy Rolled Steel..... 161
Floor Molding and Machine Molding Compared 293
Flour, Foundry, With Simple Methods of Testing 15
Flux for Removing Iron from Brass..... 496
Fluxes, Basic Mineral Co.'s..... 159
Fly Wheels, Making, Molding and Casting Large 183
Forbes & Myers, New Bench Grinder..... 245
Forced or Natural Draft..... 458
Ford Motor Co., Maximum Production in a Minimum Floor Space..... 367
Formulas for Finding the Weights of Castings, ...Data Sheets Nos. 153 and 154, January
Formulas for Finding the Weights of Castings, ...Data Sheets Nos. 155 and 156, February
Formulas for Finding the Weights of Castings, ...Data Sheets Nos. 163 and 164, June
Formulas for Finding the Weights of Castings, ..Data Sheets Nos. 169 and 170, September
Formulas for Finding the Weights of Castings, ...Data Sheets Nos. 171 and 172, October
Formulas for Finding the Weights of Castings, ...Data Sheets Nos. 173 and 174, November
Formulas for Finding the Weights of Castings, ...Data Sheets Nos. 175 and 176, December
Foundry, A Modern Wisconsin Gray Iron 61
Foundry & Machine Exhibition Co. Elects Officers 39
Foundry and Shop Equipment, Great Display of 397
Foundry, Building a New, Over Operating Shop 227
Foundry Cupola of New Design..... 469
Foundry Efficiency, Compressed Air as an Aid to 337
Foundry Efficiency, Electric-Arc Welding and 336
Foundry Floor Space, Relation of, to Output....Data Sheets Nos. 157 and 158, March
Foundry Flour With Simple Methods of Testing 15
Foundry, How on Old Gray Iron, Was Modernized 1
Foundry Industry, Statistics of the America 419
Foundry Inefficiencies and Practices, Current 344
Foundry, Making the Gray Iron, Pay Dividends 94
Foundry, Modern Two-Story, for Pipe Fittings 355
Foundry, Novel Arrangement of a Continuous 11
Foundry Operations Can be Standardized, How 98
Foundry Pay, Making the..... 299
Foundry Practice, A New Departure in Steel 75
Foundry Practice, Notes on, by a Trade Veteran 290
Foundry Rigs, Will Make..... 168
Foundry, The Brass, of the Future..... 71
Foundry, The Old Boyden, Passes Into History 247
Foundry, The Value of Saving Seconds in the 347
Foundry Work, Application of Electricity to 29
Foundryman's Difficulties, Side Lights on. 127
Foundrymen Discuss Many Important Problems 383
Foundrymen's Convention, Preparation for 239
Foundrymen's Conventions, Advance Programs of 277
Freeman, S., & Sons Mfg. Co., New Combination Molding Machines..... 199
From the Seat of the War in Mexico... 182
Furnace, Electric, for Copper Alloys..... 77
Furnace, Elevated Crucible..... 465
Furnace for Brass, Electric..... 487
Furnace, Malleable, Difficulties..... 408

G

Gagger Costs, Cutting 214
Galvanizing Malleable Iron Castings..... 470
Ganister Lining in Side-Blow Converters.. 441
Gate, Skim, Description of..... 290
Gating Stove Plate Patterns, Proper Method of 294
Gear Cases, Automobile, Rig for Molding. 196
Gear, Repairing Broken, by Burning-On... 117
Gear Teeth, Sawing 60
General Fire Extinguisher Co., Modern Two-story Foundry for Pipe Fittings.... 355
General Industrial Notes 40, 83, 122, 163, 203, 245, 286, 325, 382, 428, 466, 504
German Silver Difficulties..... 143
German Silver Difficulties..... 193
Glue for Polishing Wheels..... 500
Goggles and Masks, Colors of Lenses for Protective 282
Goggles, Chippers', Specifications for..... 215
Gold and Gold-Plating Solutions..... 114
Gold Finishes, Production of..... 178
Goldens' Foundry & Machine Co., Floor Molding and Machine Molding Compared 293
Goldschmidt Thermit Co., Manganese Flour 490
Gray Iron, Burning, Onto Steel..... 157
Gray Iron, How to Anneal, to Obtain Best Results 263

Gray Iron, Rust-Proofing..... 234
Grinder, An Electrically-Driven..... 159
Grinder and Sander, Combination..... 501
Grinder, New Bench..... 245
Grinder, Portable Radial Swing..... 200
Grinder, Swing, With Dust Exhaust..... 322
Grinding Machine, Ball-Bearing..... 283
Grinding Wheel Work, Promoting Safety in 129
Grinding Wheels, Adjustable Hood for... 121
Grinding Wheels, Protection Hoods for... 243
Grinding Wheels, Safety as Applied to.... 121
Grit, Steel 120

H

Hall-Holmes Mfg. Co., A New Sand-Sifting Machine 285
Handling Steel Castings With a Lifting Magnet 276
Hard and Soft Castings..... 262
Hard Brass Mixture..... 414
Hard Castings 440
Hard Copper Alloy 6
Hardening Castings with Manganese Flour 490
Hardness Testing Machine..... 161
Hardware, Builders', Mixtures for..... 496
Height of a Cupola Bed..... 55
High-Lead Bearing Metal Problem..... 219
High-Lead Bearing Metal Problem..... 302
High Pressure Anti-Friction Metal..... 23
Hints for Welders..... 311
Hoist, Portable Geared Electric..... 120
Hot Shortness Testing Machine for Aluminum 412
How an Old Gray Iron Foundry Was Modernized 1
How Foundry Operations Can be Standardized 98
How Manganese Steel Castings Are Made 132
How Plaster of Paris is Utilized for Patterns 24
How Radiator Cores Are Made Efficiently 471
How Stove Plate is Molded on Squeezers 165
How to Anneal Gray Iron to Obtain Best Results 263
How to Operate a Cupola Charging Machine 151
How to Daub the Cupola..... 150
How to Estimate Selling Prices of Castings 449
How to Figure Silicon..... 203
How to Make Your Time Studies Accurately 169
How to Prevent Pattern Shop Accidents.. 189
How to Remove Nickel Plate..... 59
How to Use Aluminum Solder..... 193
How to Use Scrap Copper Wire..... 458
How We Cast Bronze Plungers in the West 116
Hydraulic Bronze Mixture..... 143
Hydrometer, Use of the..... 59

I

Ideal Core Sand Mixer..... 242
Illinois Steel Co., Specifications for Chippers' Goggles 215
Imperfect Melting Methods..... 74
Improved Eye Protectors..... 37
Improved Sand Mixing Machine..... 244
Industrial Lighting 18
Ingersoll-Rand Co., Oil Engine-Driven Air Compressor 244
Ingot Mold Plant, New 336
International Combination Molding Machine 379
International Electric Tool Co., Electric Vibrator 285
International Molding Machines..... 18
International Specifications for Cast Iron. 317
Iridium 126
Iron, Acid Resisting 116
Iron and Steelworks Mark, Manfecual—A New Alloy 299
Iron, Chilled, Difficulties 147
Iron Chilling, To Prevent..... 408
Iron for Piston Rings..... 261
Iron, Galvanized, Copper-Plating..... 115
Iron, Protective Coatings for..... 497

J

Jackets, Adjustable Mold, for Foundry Use 377
Jackman, J. W., Co., Ltd., To Represent New Lines Abroad..... 423
Johns-Manville, H. W., Co., A Lesson in Fire Prevention 316
Johns-Manville, H. W., Co., A Water-Cooling System 316

K

Knickerbocker Co., Dust Collector..... 306
Koons Furnace Co., Elevated Crucible Furnace 465
Krause, William T., Pneumatic Jar-Ramming Machine 284

L

Labor Leaders' View of Scientific Management 353
Lacquering Small Castings..... 149
Ladle Nozzles, Standard, for Steel Foundries 402
Ladles, Foundry, The Safety Aspect of... 258
Lang, William C., Rock-Over Machine for Stove Plate 322
Lead Alloy 55
Lead, Alloying Zinc and..... 16
Lead, Equal Parts of Copper and..... 194
Lead, High, Bearing Metal Problem..219, 302
Lenoir Car Works, Simple Methods of Testing Foundry Flour..... 15
Lesson in Fire Prevention..... 316
Life of Cupola Lining..... 342
Lighting, Industrial 18
Linde Air Products Co., Commercial Oxygen Plant at Philadelphia..... 436
Liner, Method of Casting an Electric Steel 75
Liners, Casting Phosphor Bronze, Onto Steel 107
Link-Belt Data Book..... 134
Local Committees for Chicago Convention. 195
Locomotive Cylinders, Standard Specifications for, Data Sheets Nos. 167 and 168, August.
Loss of Weight from Annealing..... 226
Loss of Weight in Annealing Malleable Iron 452
Low Specific Gravity Alloy..... 73

Mc

McCormick, J. S., Co., Sulky Sand Riddler 380
McCormick, J. S., Co., Sulky Sand Riddler 465
McLain, David, Semi-Steel, Its Development and Manufacture..... 76
McLain's System 157

M

Machine for Making Cores in Multiple.... 425
Machine Tool Spindles, Bearing Mixture for 496
Magnalium, Mixing and Melting..... 144
Magnet, Lifting, Handling Steel Castings With a 276
Making Boiler Sections on Molding Machines 429
Making Malleables Under Modern Conditions 85
Making, Molding and Casting Large Fly Wheels 183
Making Pipe Pattern and Core Box in Plaster 296
Making Taper Cone Pulleys..... 134
Making the Gray Iron Foundry Pay Dividends 94
Making the Foundry Pay..... 299
Malleable Castings, Galvanized..... 470
Malleable Castings, Researches in the Annealing Process 474
Malleable Furnace Difficulties..... 408
Malleable Heats, Time of..... 440
Malleable Iron, Calculating Mixtures for 39
Malleable Iron, Changing the Composition of 6
Malleable Iron, Chemical Changes of..... 146
Malleable Iron, Loss of Weight in Annealing 452
Malleable Iron, Varying Silicon in..... 417
Malleable Zinc Alloy..... 60
Malleables Under Modern Conditions, Making 85
Manfecual—A New Alloy..... 299
Manganese Bronze, Remelting..... 22
Manganese Bronze, Tough..... 74
Manganese Bronze Castings, Large..... 157
Manganese Flour as a Surface Hardener. 490
Manganese in Cast Iron..... 147
Manganese, Removing Sulphur With..289, 452
Manganese Steel Castings, How, Are Made 132
Manufacture of Bronze Valves..... 21
Masks, Colors of Lenses for Protective Goggles and 282
Match-Plate Composition 310
Match-Plate Mixture, Aluminum..... 223
Match-Plate Molding, Development of..... 213
Matching Color of Castings..... 193
Matte Surface on German Silver..... 59
Maximum Production in a Minimum Floor Space 367
Mechanical Plating Barrel 37
Melting and Casting Non-Ferrous Metals. 362
Melting Bronze in a Cupola.....144, 193
Melting Difficulties, Aluminum..... 73
Melting Methods, Imperfect..... 74
Melting Points, Approximate, of Copper Alloys 69
Melting Sheet Steel Scrap..... 100
Melting, Volume of Air Required for..... 128
Metal, Acid-Resisting 311
Metal, High Pressure Anti-Friction..... 23
Metal Pattern Mixture..... 224
Metal Problem, High Lead Bearing..219, 302
Metal, Scrap Bearing, Use of..... 414
Metallurgic Engineering Co., Electric Furnace and Met od of Operation..... 17
Metals and Alloys Used for Die Castings. 19
Metals, Non-Ferrous, Melting and Casting. 362
Metals Recovered From Waste in 1913... 224
Mexico, From the Seat of the War in... 182
Mill Brasses 144
Misrun Castings 74
Mixing and Melting Magnalium..... 144
Mixture, Aluminum Core..... 23
Mixture, Aluminum Match-Plate..... 223
Mixture, Brass 495
Mixture, Brass Bearing..... 73
Mixture, Brass, Street Railway..... 496
Mixture, Carburetor 224
Mixture, Core, for Phosphor Bronze..... 224
Mixture for Carburetor Castings..... 194
Mixture for Driving Brasses..... 194
Mixture for Machine Tool Spindle Bearings 496
Mixture for Rolling Mill Brasses..... 273
Mixture for Trolley Wheels..... 496
Mixture, Hard Brass..... 414
Mixture, Hydraulic Bronze..... 143
Mixture, Metal Pattern..... 224
Mixture, Phosphor Bronze..... 310
Mixture, Piston Ring..... 495
Mixture, Sand, for Steel..... 116
Mixture, Silica Facing..... 146
Mixtures, Acid-Proof Bronze..... 496
Mixtures, Anode 58
Mixtures, Brass Casting 458
Mixtures, Calculating, for Malleable Iron. 39
Mixtures, Car Wheel..... 336
Mixtures for Builders' Hardware..... 496
Mixtures for Chilled Cast Iron Car Wheels 312
Mixtures, Nickel Bronze..... 273
Mixtures, Non-Ferrous 361
Mixtures, Strong Bronze..... 457
Mixtures, Yellow and Red Brass..... 310
Modern Pipe Casting..... 292
Modern Stove Co., How Stove Plate is Molded on Squeezers 165
Modern Two-Story Foundry for Pipe Fittings 355
Modern Wisconsin Gray Iron Foundry... 61
Mold Compound, Permanent..... 264
Mold, Dry Sand Blower Casting..... 133
Mold Dryer, Combination Spray Can and. 199
Mold Jackets, Adjustable, for Foundry Use 377
Moldenke, Dr., Resigns..... 162
Moldenke, Dr., Resigns Secretaryship of A. F. A. 79
Molding and Casting Large Bronze Valve Parts 205
Molding Cast Iron Flask Parts..... 442
Molding Converter Tops..... 468
Molding, Floor, and Machine Molding Compared 293
Molding Iron Boiler Bases by a New Method 53
Molding Machine, A Special Sheave..... 147
Molding Machine, International Combination 379
Molding Machine, Pneumatic Jar-Ramming 284
Molding Machine, Pridmore Combination, Jar-Ramming, Rock-Over 380
Molding Machine, Rock-Over, for Stove Plate 322
Molding Machine, Twin-Table 199
Molding Machine, Vertical Draw..... 241
Molding Machines, New Combination..... 199
Molding Machines, New Osborn..... 281
Molding, Match-Plate, Development of.... 213
Molds, Permanent 134
Molds, Pouring, by an Ingenious Method. 123
Mumford Molding Machine Co..... 18
Mummert-Dixon Co., Portable Radial Swing Grinder 200

N

National Brake & Electric Co., A Modern Wisconsin Gray Iron Foundry..... 61
National Cash Register Co., Reducing Casting Cost of Ornamental Bronze..... 135
National Founders' Association, Precautions for Safeguarding Foundry Employes 48
National Founders' Association, Promoting Safety in Grinding Wheel Work..... 129
National Founders' Association, Protecting the Eyes and Feet Against Injury..... 101
National Founders' Association, The Safety Aspect for Foundry Ladles..... 258
New Brazing Material..... 316
New Castings Plant in the Automobile City 175
New Departure in Steel Foundry Practice 75
New England Foundrymen Elect Officers.. 68
New England Foundrymen's Association.. 366
New Jersey Foundry & Machine Co., Crucible Tongs 462
New Plant for Oven Equipment Co..... 239
Nickel Alloys 144
Nickel Bronze Mixtures..... 273
Nickel Plate, Blistering of..... 149
Nickel Plate, How to Remove..... 59
Nickel Solutions, Discussion of Rapid..... 300

Nickel Tank, A Properly-Equipped..... 233
Nomenclature of Alloys, Progress in..... 413
Non-Ferrous Alloy Test Problem..... 141
Non-Ferrous Metals, Melting and Casting. 362
Non-Ferrous Mixtures 361
Non-Ferrous Test Specimens Compared.... 268
Norton Co., Protection Hoods for Grinding Wheels 243
Notes on Foundry Practice by a Trade Veteran 290
Notes on Galvanizing Malleable Iron Castings 470
Novel Arrangement of a Continuous Foundry 11

O

Offers Course to Foundry Foremen in Membership Contest 93
Oil Engine-Driven Air Compressor..... 244
Open-Hearth, Successfully Operating a 3-Ton 108
Operating a Brass Foundry Under Difficulties 361
Orders, "Express," Facilitating the Handling of 148
Ornamental Castings 273
Osborn Mfg. Co. Expands 235
Osborn Mfg. Co., New Osborn Molding Machines 281
Otis Elevator Co., Cutting the Cost of Molding Sheave Wheels 287
Otis Elevator Co., Inclined Elevator to Charging Platform 283
Oven Equipment Co.'s New Plant..... 239
Overcoming Shrinkage in Bronze..... 223
Oxidation, Difficulties Due to..... 458
Oxygen Plant, Commercial, at Philadelphia 436

OBITUARIES:
Herman, Charles 279
Loder, Morris G. 311
Platt, Capt. Alfred 218
Sperry, E. S. 121

P

Papers for A. F. A. Meeting and the Exhibitors 315
Pattern, Herringbone Grate, Making a... 448
Pattern Lumber, Board Feet in.....
..Data Sheets Nos. 159 and 160, April
Pattern Lumber, Board Feet in.....
..Data Sheets Nos. 161 and 162, May
Pattern, Making Pipe, and Core Box in Plaster 296
Pattern Mixture, Metal 224
Pattern Plate Composition, New..... 47
Patterns, Fitting 266
Patterns for Repetition Work..... 133
Patterns, How Plaster of Paris is Utilized for 24
Patterns, Proper Construction of..... 54
Patterns, Red Metal for..... 273
Patterns, Stove Plate, Proper Method of Gating 294
Patterns, Use of Plaster of Paris for Making 256
Perimeter of Girth Table for Determining the Weight of Iron Castings.....
.....Data Sheets No. 165, July
Pettinos Bros., Sorting and Curing Plumbago in Far-off Ceylon..... 265
Permanent Mold Compound..... 264
Permanent Molds 134
Personal 39,
82, 121, 162, 202, 218, 324, 381, 423, 462
Peterson-National Co. Absorbed..... 161
Phillips-Lafitte Co., A New Brazing Material 316
Philosophy of an Alloy..... 491
Phosphor Bronze, Cheap 108
Phosphor Bronze, Core Mixture for..... 224
Phosphor Bronze Difficulties 108
Phosphor Bronze Mixture 310
Pig Iron, Effects of Vanadium on Properties of 303
Pig Iron Specifications, International Association for Testing Materials..... 319
Pipe Casting, Modern..... 292
Pipe Fittings, Modern Two-Story Foundry for 355
Pipe Pattern and Core Box, Making, in Plaster 296
Pipe Plant for Australia..... 316
Piston Ring Mixture..... 495
Piston Rings, Iron for..... 261
Pittsburgh Crushed Steel Co., Steel Grit.. 120
Pittsburgh Emery Wheel Co., Swing Grinder With Dust Exhaust 322
Plain Talk About Selling Castings..... 242
Planer, Portable Bench 322
Plaster of Paris, How, is Utilized for Patterns 24
Plaster Pattern for a Conveyor Screw.... 156
Plates, Aluminum, Wavy Surface on..... 108
Plating Barrel, A Mechanical..... 37
Plating, Copper-, Galvanized Iron..... 115
Plating Deposits, Durable 35
Plating, Gold and Gold-, Solutions..... 114
Plating Plant, Experimental..... 275
Plating Room, Efficiency in the..... 57
Plumbago, Sorting and Curing, in Far-off Ceylon 265
Plungers, How We Cast Bronze, in the West 116
Pneumatic Cupola Process..... 146
Pneumatic Jar-Ramming Machine..... 284
Polishing Aluminum Castings..... 302
Polishing Wheels, Glue for..... 500
Porcelain, Electro-Silvering 150
Porous Brass Sleeves..... 107
Portable Bench Planer..... 322
Portable Electric Tools..... 202
Portable Geared Electric Hoist..... 120
Portable Radial Swing Grinder..... 200
Pouring Molds by an Ingenious Method.. 123
Precautions for Safeguarding Foundry Employes 48
Preparations for Foundrymen's Convention 239
Pridmore Combination, Jar-Ramming, Rock-Over Machine 380
Prime Steel Co., Titanium Steel Converter Tops 468
Production, Economy in, of Miscellaneous Work 298
Production of Gold Finishes..... 178
Production, Maximum, in a Minimum Floor Space 367
Productograph, The 284
Program, American Foundrymen's Association 329
Program, American Institute of Metals... 331
Program of Foundrymen's Conventions, Advance 277
Progress in Nomenclature of Alloys..... 413
Promoting Safety in Grinding Wheel Work 129
Proper Construction of Patterns..... 54
Proper Method of Gating Stove Plate Patterns 294
Properly-Equipped Nickel Tank..... 233
Proportions of a Cupola..... 257
Protecting the Eyes and Feet against Injury 101
Protection Hoods for Grinding Wheels... 243
Protective Coatings for Iron..... 497
Providence Core Sand..... 436
Pulleys, Making Taper Cone..... 134
Pullman Co., Safety and Sanitation in the Brass Foundry 394

Q

Quigley Furnace & Foundry Co., How to Operate a Cupola Charging Machine 151

R

Radiator Cap, Enamel for Automobile... 58
Radiator Cores, Made Efficiently..... 471
Range Tops, Rusting of Cooking..... 66
Rat Tails and Scabbing on Castings..... 52
Ransom Mfg. Co., Ball-Bearing Grinding Machine 283
Rebuilding an Old Cupola 10
Record-Breaking Production of Aluminum 417
Red and Yellow Brass Mixtures 310
Red Metal for Patterns 273
Reducing Casting Cost of Ornamental Bronze 135
Relation of Foundry Floor Space to Output .....
..Data Sheets Nos. 157 and 158, March
Relative Efficiencies of Sand Blast Nozzles. 145
Remelting Manganese Bronze 22
Remodeling an Old Cupola 408
Removing Iron From Brass 496
Removing Sulphur with Manganese..289, 452
Repairing Broken Gear by Burning-On.. 117
Researches in the Annealing Process for Malleable Castings 474
Results Accomplished by Scientific Management—I 459
Results Accomplished by Scientific Management—II 498
Riddle, All-Steel Foundry 82
Riddle, New Steel Foundry 121
Rig for Molding Automobile Gear Cases 196
Rig for Molding Sanitary Ware 381
Rigs, Foundry, Will Make 168
Riverside Steel Casting Co., Successfully Operating a 3-Ton Open-Hearth 108
Rock-Over Machine for Stove Plate 322
Roedell, W. A., Combination Spray Can and Mold Dryer 199
Rolled Steel Flasks, Heavy 461
Rolling Mill Brasses, Mixture for 273
Rolls, Aluminum 311
Rundle-Spence Mfg. Co., Sanitary Drinking Fountains 276
Rust-Proofing Gray Iron 234
Rusting of Cooking Range Tops 66

S

Safeguarding Foundry Employes, Precautions for 48
Safety and Sanitation in the Brass Foundry 394
Safety as Applied to Grinding Wheels.. 121
Safety Aspect of Foundry Ladles 258
Sand Blast Barrel 427
Sand Blast, Evans High Pressure 160
Sand Blast from Viewpoint of the User.. 210
Sand Blast Machine, Automatic 465
Sand Blast Nozzles, Relative Efficiencies of 145
Sand Brass Foundry 272
Sand, Economies in the Manipulation of. 197
Sand-Handling Apparatus 279
Sand Mixer, Ideal Core 242
Sand Mixer, Simpson 323
Sand Mixing Machine Co., Improved Sand Mixing Machine 244
Sand Mixing Machine Co. Orders 39
Sand Mixture for Steel 116
Sand Riddler, Sulky 380, 465
Sand-Sifting Machine, A New 285
Sandwich Mfg. Co., A Special Sheave Molding Machine 147
Sanitary Drinking Fountains 276
Sanitary Ware, Rig for Molding 381
Satin Finish on Aluminum 500
Saving Seconds, The Value of, in the Foundry 347
Sawing Gear Teeth 60
Scabbing and Rat Tails on Castings 52
Scientific Management in Foundry Operations 437
Scientific Management in the Foundry—I 443
Scientific Management in the Foundry—II 479
Scientific Management, Labor Leader's View of 353
Scientific Management, Results Accomplished by,—I..... 459
Scientific Management, Results Accomplished by,—II..... 498
Scientific Management, Task and Bonus Work 280
Scrap Bearing Metal, Use of 414
Scrap Copper Wire, How to Use 458
Scrap, Melting Sheet Steel 100
Screws, Machine, Alloy for 457
Selling Castings, Plain Talk About..... 242
Selling Prices of Castings, How to Estimate 449
Semi-Steel, Its Development and Manufacture 76
Sheave Molding Machine, A Special 147
Sheave Wheels, Cutting the Cost of Molding 287
Shot Iron in Cupola, Test of Melting ... 467
Shrinkage, Aluminum 23
Shrinkage and Expansion 82
Shrinkage, Overcoming, in Bronze 223
Shrinkage, Unnatural 440
Side Lights on the Foundryman's Difficulties 127
Silica, Dissolved, Elimination of 457
Silica Facing Mixture 146
Silicon, How to Figure 203
Silicon, Varying, in Malleable Iron 417
Silver, German, Matte Surface on..... 59
Simpson Sand Mixer 323
Skim Gate, Description of 290
Sleeves, Porous Brass 107
Slocum, Avram & Slocum, Inc., The Productograph 284
Slow Cupola Melting 214
Sly, W. W., Mfg. Co., Automatic Sand Blast Machine 465
Smith, H. B., Co., Making Boiler Sections on Molding Machines 429
Smith, H. B., Co., Radiator Shop 471
Smooth-On Mfg. Co., Waterproofing Material 468
Snap Flask, Adjustable Aluminum 323
Solder Aluminum 108, 223
Solder, Aluminum, How to Use 193
Soldering White Metal 496
Solid Castings 354
Solutions, Discussion of Rapid Nickel.... 300
Solutions, Gold and Gold-Plating 114
Sorting and Curing Plumbago in Far-off Ceylon 265
Southern Michigan Foundrymen's Association 202
Southern Michigan Foundrymen's August Meeting 302
Southern Michigan Foundrymen's Association Meeting 294
Specification for Chippers' Goggles 215
Specifications, International, for Cast Iron 317
Spokes Casting Steel, into Hubs 292
Spotted Finishes, Cause of 234
Spray Can and Mold Dryer, Combination 199
Sprue, Arcade Spring 201
Squeezer, A Stationary Head 80
Squeezer, Tabor 8-Inch Power 81
St. Louis Smelting & Refining Co., Requests Catalogs 393
Standard Brass Foundry Co., A Large Aluminum Crank Case 262
Standard Electric Tool Co., Portable Electric Tools 202

Standard Improved Truck Co., Welded Truck 230
Standard Ladle Nozzles for Steel Foundries 402
Standard Specifications for Locomotive Cylinders .....Data Sheets Nos. 167 and 168, August
Stationary Head Squeezer 80
Statistics of the American Foundry Industry 419
Steel, Burning Gray Iron Onto 157
Steel, Casting Phosphor Bronze Liners Onto 107
Steel Foundries, Standard Ladle Nozzles for 402
Steel Foundry Riddle 121
Steel Grit 120
Steel, Sand Mixture for 116
Sterling Wheelbarrow Co., Heavy Rolled Steel Flasks 161
Stove Plate, Early Manufacture of Cast Iron 216
Stove Plate, How, is Molded on Squeezers 165
Stove Plate Made From Shot Iron Mixture 467
Stove Plate Patterns, Proper Method of Gating 294
Stove Plate, Rock-Over Machine for..... 322
Street Railway Brass Mixture 496
Strengthening No. 12 Aluminum Alloy... 74
Studebaker Bros. Mfg. Co.'s Gray Iron Foundry 1
Sturtevant, B. F., Co., An Unusual Forge Fan 442
Successfully Operating a 3-Ton Open-Hearth 108
Suggestions for Making Aluminum Castings 67
Sulky Sand Riddler 380, 465
Sullivan Machinery Co., Compressed Air as an Aid to Foundry Efficiency 337
Sulphur in Alloys 74
Sulphur, Removing, with Manganese 289
Sulphur, Removing, With Manganese ... 452
Swing Grinder With Dust Exhaust 322

T

Table for Finding Weights of Castings.. .....Data Sheet No. 166, July
Tabor 8-Inch Power Squeezer 81
Taper Flask 501
Task and Bonus Work 280
Telpher Systems Applied to Foundry Operations 41
Terry Steam Turbine Co., Appoints Panama Agents 343
Test on Melting Shot Iron in Cupola ... 467
Test Problem, Non-Ferrous Alloy 141
Test Specimens, Non-Ferrous, Compared. 268
Testing Foundry Flour, Simple Methods. of 15
Testing Machine, A Hot Shortness, for Aluminum 412
Thomas Iron Co., Effects of Vanadium on Properties of Pig Iron 303
Thompson, Warner R., Co. 97
Time of Malleable Heats 440
Time Studies, How to Make Your, Accurately 169
Titanium Steel Converter Tops 468
Too Much Coke on the Bed.....162, 306
Tool, Vacuum Cleaner as Foundry 14
Tools, Portable Electric 202
Trade Notes 324
Trade Publications 40, 164 204, 286, 326, 382, 428, 466, 504
Trolley Wheel Mixture 496
Tropenas Converter Co., Manufacture of Steel Castings 316
Tropenas Converter Heat Record, Wonderful 235
Tropenas Converter Versus Electric Furnace 180
Truck, A Welded 230
Tuyere Area of the Cupola 418

U

Union Foundry Co., Molding Iron Boiler Bases by a New Method 53
United States Match Plate Co. 150
Unnatural Shrinkage 440
Use and Care of Crucibles 307
Use of Plaster of Paris for Making Patterns 256
Use of Scrap Bearing Metal 414
Use of Scrap Copper 414
Use of the Hydrometer 59

V

Vacuum Cleaner as Foundry Tool 14
Valley City Machine Works, Adjustable Hood for Grinding Wheels 121
Valley Mould & Iron Co., New Ingot Mold Plant 336
Value of Saving Seconds in the Foundry 347
Valve, Brass, Troubles 23
Valve Parts, Molding and Casting Large Bronze 205
Valves, Bronze, Manufacture of 21
Vanadium Effects of, on Properties of Pig Iron 303
Varying Silicon in Malleable Iron 417
Vibrator, Electric 285
Victor Bronze 60
Volume of Air Required for Melting.... 128

W

Wadsworth Core Machine & Equipment Co., A New Machine for Making Cores in Multiple 425
Wallace, John D., Portable Bench Planer 322
Water-Cooling System 316
Waterproofing Material 468
Wavy Surface on Aluminum Plates 108
Webster & Perks Tools Co., An Electrically Driven Grinder 159
Welded Truck 230
Welders, Hints for 311
Welding, Electric-Arc, and Foundry Efficiency 336
Westinghouse Air Brake Co., Building a New Foundry Over Operating Shop.. 227
White Metal, How to Solder 496
White Spots on Brass Castings 458
Whitehead Bros. Co., Providence Core Sand 436
Whiting Crane Catalog 292
Whiting Foundry Equipment Co., New Design of Cupola 469
Why the Analysis 440
Willson Company Expands 202
Willson, T. A., & Co., Improved Eye Protectors 37
Wire Scrap Copper, How to Use 458
Wonderful Tropenas Converter Heat Record 235
Woodison Co. Expands 161
Wood's, T. B., Sons Co.. Adjustable Mold Jackets for Foundry Use 377
Wright Wire Co., A New Steel Foundry Riddle 121

Y

Yellow and Red Brass Mixtures 310

Z

Zinc Alloy Die Castings, Electro-Plating 232
Zinc and Lead, Alloying 16
Zinc, Malleable, Alloy 60

Authors' Index to Volume XLII

January---December, 1914

A

Ach, C. L., Removing Sulphur With Manganese 452
Andrews, Arthur, How We Cast Bronze Plungers in the West 116

B

Backert, A. O., How to Estimate Selling Price of Castings 449
Barnes, E. A., Drop-Pouring Process of Casting Bronze 415
Bennett, T. Ben, The Cupola Bridging Problem 268
Brandon, G. R., Cupola of New Design.. 469
Buchanan, Robert, How to Anneal Gray Iron to Obtain Best Results 263
Burgess, G. K., Progress in Nomenclature of Alloys 413

C

Carew Jr., William J., Plaster Pattern for a Conveyor Screw 156
Clamer, G. H., Electric Furnace for Copper Alloys 77
Clamer, G. H., and Carl Hering, Electric Brass Melting Furnace 487
Clarke, R. R., Philosophy of an Alloy ... 491
Clarke, Russell R., The High Lead Bearing Metal Problem 219
Cooney, Lloyd S., Development of Match-Plate Molding 213
Custer, Edgar Allen, Another View on Cupola Bridging 268

D

Dean, Stuart, Making the Gray Iron Foundry Pay Dividends 94

E

Edward J., Making the Foundry Pay... 299
Elliott, W. B., Electric-Arc Welding and Foundry Efficiency 336
Estep, H. Cole., Making Malleables under Modern Conditions 85
Estep, H. Cole. Maximum Production in a Minimum Floor Space 367
Estep, H. Cole, Rig for Molding Automobile Gear Cases 196
Evans, G. S., Foundry Flour With Simple Methods of Testing 15

F

Fitch Jr., Edwin O., Effects of Vanadium on Properties of Pig Iron 303
Fleeger, Burtner, Facilitating the Handling of "Express" Orders 148
Fraser, W. D., Dry Sand Blower Casing Mold 133
Frey, John P., Manufacture of Cast Iron Stove Plate 216
Frey, John P., Labor Leader's View of Scientific Management 353

G

Gard, J. L., Making a Herringbone Grate Pattern 448
Garrett, W. W., Vacuum Cleaner as Foundry Tool 14
Gates, H. D., The Sand Blast from Viewpoint of the User 210
Gillett, H. W., and A. B. Norton, Approximate Melting Points of Copper Alloys 69
Golden J. P., Floor Molding and Machine Molding Compared 293
Gordon, B., Making, Molding and Casting Large Fly Wheels 183
Gordon, D., Making Pipe Pattern and Core Box in Plaster 296
Gradenwitz, Dr. Alfred Telpher Systems Applied to Foundry Operations 41
Greyson, John, Ganister Lining in Side Blow Converters 441

H

Hemenway, Harrold, Calculating Mixtures for Malleable Iron 39
Hemenway, Harrold, Malleable Furnace Difficulties 408
Hemenway, Harrold, Time of Malleable Heats 440
Hering, Carl, and G. H. Clamer, Electric Brass Melting Furnace 487
Hutton, Mancius S., How to Prevent Pattern Shop Accidents 189

K

Karr, C. P., The Brass Foundry of the Future 71
Keep, W. J., Casting Steel Spokes into Hubs 292
Keep, W. J., Charge for a 28-Inch Cupola 452
Keep, W. J., Chilled Iron Difficulties ... 147
Keep, W. J., Coke Recovered from the Cupola Dump 447
Keep, W. J., Cracking of Mine Car Wheels 319
Keep, W. J., Cupola Bridging Problem... 162
Keep, W. J., Distance of Tuyeres from Sand Bottom 418
Keep, W. J., Expansion of Cast Iron 177
Keep, W. J., Hard Castings 440
Keep, W. J., Height of a Cupola Bed ... 55
Keep, W. J., How to Daub the Cupola... 150
Keep, W. J., How to Figure Silicon..... 203
Keep, W. J., Iron for Piston Rings..... 261
Keep, W. J., Life of Cupola Lining..... 342
Keep, W. J., Loss of Weight in Annealing Malleable Iron 452
Keep, W. J., Loss of Weight from Annealing 226
Keep, W. J., Manganese in Cast Iron.... 147
Keep, W. J., Permanent Molds 134
Keep, W. J., Proportions of a Cupola... 257
Keep, W. J., Rebuilding an Old Cupola... 10
Keep, W. J., Remodeling an Old Cupola.. 408
Keep, W. J., Removing Sulphur with Manganese 289
Keep, W. J., Rusting of Cooking Range Tops 66
Keep, W. J., Scabbing and Rat Tails on Castings 52
Keep, W. J., Shrinkage and Expansion... 82
Keep, W. J., Slow Cupola Melting 214
Keep, W. J., To Prevent Iron Chilling ... 408
Keep, W. J., Too Much Coke on the Bed 162
Keep, W. J., Unnatural Shrinkage 440
Keep, W. J., Volume of Air Required for Melting 128
Keep, W. J., Why the Analysis 440
Kennedy, R. E., and J. C. Pendleton, Economy in Production of Miscellaneous Work 298
Kennedy, R. E., and J. C. Pendleton, How Foundry Operations Can Be Standardized 98
Kennedy, R. E., and J. C. Pendleton, The Value of Saving Seconds in the Foundry 347
Kent, Robert Thurston, Scientific Management in Foundry Operations 437
King, F. W., Colors of Lenses for Protective Goggles and Masks 282
Knight, S. S., A New Departure in Steel Foundry Practice 75
Knoeppel, C. E., Current Foundry Inefficiencies and Practices 344
Knoeppel, C. E., How to Make Your Time Studies Accurately 169
Kreutzberg, E. C., Cutting the Cost of Molding Sheave Wheels 287
Kreutzberg, E. C., How to Operate a Cupola Charging Machine 151
Kreutzberg, E. C., Making Boiler Sections on Molding Machines 429
Kreutzberg, E. C., The Old Boyden Foundry Passes into History 247

L

Lake, E. F., Metals and Alloys Used for Die Castings 19
Later, E. P., Efficiency in the Plating Room 57
Later, E. P., Protective Coatings for Iron 497
Liscomb, N., Cutting Gagger Costs 214
Liston, John, Application of Electricity to Foundry Work 29

Mc

McGowan, R. R., How Plaster of Paris is Utilized for Patterns 24
McGowan, R. R., Perimeter of Girth Table for Determining the Weight of Iron Castings, Data Sheet No. 165, July

M

Miller, H. H., From the Seat of the War in Mexico 182
Miller, H. H., Operating a Brass Foundry Under Difficulties 361
Moerl, Fred, Safety and Sanitation in the Brass Foundry 394
Moldenke, Dr. Richard, Chemical Changes of Malleable Iron 146
Muntz, G., Tropenas Converter Versus Electric Furnace 180
Murphy, H. J., Fitting Patterns 266

N

Nailler, Raymond F., The Art of Enameling Cast Iron and Steel 7
Nock, A. W., Board Feet in Pattern Lumber, Data Sheets Nos. 161 and 162, May.
Nock, A. W., Board Feet in Pattern Lumber, Data Shets Nos. 159 and 160, April.
Norton, A. B., Aluminum Die Castings 455
Norton, A. B., A Hot Shortness Testing Machine for Aluminum 412
Norton, A. B. and H. W. Gillett, Approximate Melting Points of Copper Alloys 69

O

Osswald, Franz, A Device for Preventing Cupola Explosions 267

P

Parkhurst, F. A., Scientific Management in the Foundry—I 443
Parkhurst, F. A., Scientific Management in the Foundry—II 479
Parry Jr., W. H., Use of Plaster of Paris for Making Patterns 256
Pendergast, J., Compressed Air as an Aid to Foundry Efficiency 337
Pendleton, J. C., and R. E. Kennedy, Economy in Production of Miscellaneous Work 298
Pendleton, J. C., and R. E. Kennedy, How Foundry Operations Can Be Standardized 98
Pendleton, J. C., and R. E. Kennedy, The Value of Saving Seconds in the Foundry 347
Pickup, G. E., Test on Melting Shot Iron in Cupola 467
Pollard, A. L., Varying Silicon in Malleable Iron 417

R

Ray, C., Sawing Gear Teeth 60
Ramp, Paul R., Solid Castings 354
Ramp, Paul R., The Proper Construction of Patterns 54
Reddy, B. H., Relative Efficiencies of Sand Blast Nozzles 145
Rhead, E. L., The Design and the Operation of the Cupola 252
Rodigin, P., Changing the Composition of Malleable Iron 6
Rowsbar, Seymour W., Discussion of Rapid Nickel Solutions 300
Rowsbar, Seymour W., Durable Plating Deposits 35
Rowsbar, Seymour W., Gold and Gold-Plating Solutions 114
Rowsbar, Seymour W., Results Accomplished by Scientific Management—I.. 459
Rowsbar, Seymour W., Results Accomplished by Scientific Management—II.. 498
Rowsbar, Seymour W., The Production of Gold Finishes 178

S

Scantlebury, F. H., Plain Talk About Selling Castings 242
Sender, J. L., The Manufacture of Bronze Valves 21
Skillman, V., The Non-Ferrous Alloy Test Problem 141
Stacks, G. Roy, Repairing Broken Gear by Burning-On 117
Storey, Oliver W., Recent Changes in the Annealing Process for Malleable Castings 474
Stowe, S. R., Side Lights on the Foundryman's Difficulties 127
Sweich, John, Molding Cast Iron Flask Parts 442

T

Taylor, J. H., Too Much Coke on the Bed 306
Thompson, A. M., Economies in the Manipulation of Sand 197
Tonkin, Ellsworth, Building a New Foundry Over Operating Shop 227
Torch, Arnold, A Welded Truck 230
Touceda, Enrique, Notes on Galvanizing Malleable Iron 470
Tryon, W. L., Formulas for Finding the Weights of Castings, Data Sheets Nos. 153 and 154, January.
Tryon, W. L., Formulas for Finding the Weights of Castings, Data Sheets Nos. 155 and 156, February.
Tryon, W. L., Formulas for Finding the Weights of Castings, Data Sheets Nos. 163 and 164, June.
Tryon, W. L., Formulas for Finding the Weights of Castings. Data Sheets Nos. 169 and 170, September.
Tryon, W. L., Formulas for Finding the Weights of Castings. Data Sheets Nos. 171 and 172, October.
Tryon, W. L., Formulas for Finding the Weights of Castings, Data Sheets Nos. 173 and 174, November.
Tryon, W. L., Formulas for Finding the Weights of Castings. Data Sheets Nos. 175 and 176, December.

V

Vickers, C., Melting and Casting Non-Ferrous Metals 362

W

Webb, J. F., Burning Gray Iron Onto Steel 157
Wilson, Samuel, Reducing Casting Cost of Ornamental Bronze 135

Z

Zerhansen, F. R., How Manganese Steel Castings Are Made 132
Zimmerschied, K. W., A Cast Iron of Unusual Interesting Structure..... 404

Data Sheets, Volume XLII

January---December, 1914

Nos. 153 and 154, January, Formulas for Finding the Weights of Castings.

Nos. 155 and 156, February, Formulas for Finding the Weights of Castings.

Nos. 157 and 158, March, Relation of Foundry Floor Space to Output.

Nos. 159 and 160, April, Board Feet in Pattern Lumber.

Nos. 161 and 162, May, Board Feet in Pattern Lumber.

Nos. 163 and 164, June, Formulas for Finding the Weights of Castings.

No. 165, July, Perimeter of Girth Table for Determining the Weight of Iron Castings.

No. 166, July, Table for Finding Weights of Castings.

Nos. 167 and 168, August, Standard Specifications for Locomotive Cylinders.

Nos. 169 and 170, September, Formulas for Finding the Weights of Castings.

Nos. 171 and 172, October, Formulas for Finding the Weights of Castings.

Nos. 173 and 174, November, Formulas for Finding the Weights of Castings.

Nos. 175 and 176, December, Formulas for Finding the Weights of Castings.